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The Chicago Drainage Commission has received the report of Chief Engineer Benezette Williams. This lengthy report dealt with the older locations or routes, and outlined an entirely new route to be built upon at an estimated cost of $12,060,000, or much less than any plan so far submitted. He also believes that mill site property, to the value of $7,200,000, would be created by the later plan. Meantime, the Board of Sanitary Trustees has practically decided to pay the expense of pumping 80,000 cu. ft. of water per minute into the Illinois and Michigan Canal, and repairing the canal so that it can carry off the added supply.

The American Contracting and Dredging Co., which was organized in 1883 to take contracts on the construction of the Panama Canal, and which did about the only thoroughly successful work which was done on that unfortunate enterprise, is to be dissolved, by mutual agreement of its stockholders. The financial success of the company has been an enviable one. Organized with a nominal capital of $2,000,000, it has paid to its stockholders in the eight years since its organization dividends amounting to $7,610,000 and $675,000 on stock of other companies held. Among those interested in the company were Henry B. Slaven, Jas. J. Phelan, Chas. M. Fry, Wm. H. Mackey and Eugene and Edward Kelly.

The will of the late Thos. Sterry Hunt bequeaths 40 shares of stock of a Montreal bank to each of three institutions, the Quebec Seminary, McGill College, and the Massachusetts Institute of Technology. The money is to be used for the establishment of scholarships in chemistry. Each institution is also to receive a cash bequest of $2,000.

The wind gage on the Forth Bridge registered a pressure of 21¼ lbs. per sq. ft. on Jan. 29. As high a pressure as 36 lbs. per sq. ft. has been shown on this gage.

Coal was found last year in Spitzbergen by Herr Crennen, of Berlin. He found many beds, 450 ft. being the thickest, and one 4½ ft. vein extended along the coast for over 4 miles. This coal lies in the Jura and Miocene strata, and is said to be better than German coal of the same period.

The gross earnings of 139 railways for the month of January, 1892, according to the "Financial Chronicle," aggregate $39,718,075 as compared with $38,724,279 for the corresponding month of 1891, an increase of 2.57%. This is not so satisfactory a showing as would be wished considering the large grain movement, but various unfavorable influences have largely counteracted the benefits resulting from the heavy crops. Among these were the greatly decreased cotton and live stock movements, and the bad weather in certain sections of the country. Some of the larger systems show very large increases, but on the other hand there are some which exhibit unusually heavy decreases. Of the total 139 roads, 73 show decreases. The Chicago, Milwaukee & St. Paul has the largest gain, $174,721, and the Northern Pacific the largest decrease, $311,931. There are 26 roads showing increases of over $30,000, and 25 roads showing losses of the same amount.

The Quaker City Elevated Railway ordinance has been signed by the Mayor of Philadelphia. This ordinance provides for a double track road on Market St., from Front to Ninth St., out Ninth to Ridge Ave., and out that street to Lehigh Ave. Branch roads are provided for from Ninth and Market, and Juniper to South Penn. Square and Broad St., thence along Market St. to the county line. Also from the junction of Market St. and Lancaster Ave. to the intersection of the latter street and Forty-fourth St., and out Forty-fourth St. to Fairmount Park, and another branch from Market St. out Woodland Ave. to the county line. The fare is to be 5 cts. from 6 to 9 a. m., and from 5:30 to 7:30 p. m.; at all other hours 10 cts. There must be a clearance of not less than 14 ft. at all places and 20 ft. over steam railways. Work must be commenced within six months, otherwise the ordinance is void.

A consolidated, descriptive index to current engineering literature, published by the Board of Managers of the Journal of the Association of Engineering Societies, John W. Weston, Secretary, 78 La Salle St., Chicago, being a condensation under one alphabet of the notes which have appeared monthly in the association's "Journal" is announced. It will contain about 450 finely printed pages, will be ready in April, and may be ordered now of the secretary at $2.50 per volume. We have no doubt it will be a valuable and useful publication.

The new Chicago four-mile lake tunnel is being examined by civil engineers Robert E. McMath and George H. Benzenberg as experts. They will examine and report on the construction and find out if any material departure has been made from the original specifications. They do this under the instructions of the City Councils.

The deep-water convention of Jan. 27, convened at Corpus Christi, Tex., was a success. At least $250,000 is said to have been subscribed in lands and cash for the completion of the work on Ropes Pass, through Mustang Island, into the Gulf of Mexico.

The most serious railway accident of the week was a derailment, Feb. 18, near Houston, Tex., on the San Antonio & Aransas Pass R. R. A switch engine hauling a train of flat cars jumped the track and fell over on its side. There were three persons killed and four injured.—On Feb. 20 a milk train on the Housatonic R. R. ran into the rear end of a disabled freight train near Cannon's, Conn., owing to the engineer of the milk train not seeing the flagman sent back from the freight train. One man was killed and two were seriously injured. The engine and several cars were wrecked.

A sewer tunnel accident occurred at Seattle, Wash., Feb. 14. A sudden rush of quicksand caught three men who were at work 1,200 ft. from the mouth of the new Lake Union tunnel. One man was killed, being buried in the quicksand, and another was injured.

The Interstate Committee on Uniformity of Railway Accounts, as a preliminary to the adjourned meeting to be held at the Windsor Hotel, New York, on Tuesday, March 22, 1892, when the questions below will be considered, has issued a circular to state railway commissioners and accountants asking for opinions on the following points:

1. Whether "Taxes" shall or shall not be included as a separate item in "Operating Expenses."

2. Whether the assignment of expenses to freight and to passenger traffic shall be continued.

3. Whether the expense of moving express and mail shall be taken into account in order to declare the cost per passenger per mile.

4. Whether it is wise to transfer many items mentioned from "General Expenses" to "Conducting Transportation."

We have no means of knowing what views the committee will reach on these points, but it strikes us that (1) taxes should certainly be included in operating expenses, as there is no other appropriate place for them; (2) that any attempt at accurate division of expenses between passenger and freight traffic is the rudest kind of guesswork, and may as well be abandoned; (3) that both receipts and expenses from express and mail matter ought to be deducted before determining costs per passenger mile, and (4) that both the items of "Conducting Transportation" and "General Expenses" are made up of so many and such incongruous items that neither has much meaning or value to students of transportation. They might quite as well be lumped together in one item.

An electric tender is now attached to the vestibuled limited train between Chicago and Milwaukee. This is a steel car, 33 ft. long, 9 ft. wide and weighing 65,000 lbs. It contains in one of its two compartments a tubular boiler 13 ft. 9 ins. long, with its furnace. In the other compartment are a Westinghouse engine, an Edison dynamo, a steel water tank, and all the apparatus necessary for equipping a small electric light station. The boiler is used for supplying steam to the dynamo engine and for heating 10 cars in the train. In summer the tender is to be detached, and the dynamo, placed in the baggage car, will be run by steam from the locomotive. The dynamo usually supplies 154 lights, one over each chair in the drawing room car and one in each sleeping berth.

The American Aluminum Co. has started an experimental plant in Philadelphia, working on the patents of Mr. E. C. Broadwell. The very wild claim is made that by this system aluminum can be produced at "one cent per pound," with profit.

Progress on the Memphis bridge, across the Mississippi River, to date, is reported as follows by our correspondent: The east approach is completed and the rail laid to the bridge entrance. On the west approach the grading and trestle work are finished and the iron and steel viaduct is erected, but the riveting is not yet completed. On the main bridge all the superstructure is up excepting the free span between the cantilever arms from piers I. and II. Messrs. Baird Bros., the contractors for erection, are now at work on this span, and expect to complete it by May 1. It is expected that the whole bridge will be ready for traffic by May 15. We illustrate this bridge on another page.

The English Institution of Mechanical Engineers held its 45th annual meeting in London lately, and showed the following record of membership: Present membership, 2,077, a gain of 134 since the previous annual meeting. The capital of the institution amounts to $190,000, chiefly invested in railway debenture stock. Dr. William Anderson is the new President, and among the Vice-Presidents is Sir Douglas Galton.

The Busk tunnel, on the Colorado Midland Ry., is progressing at both ends at the rate of 840 ft. per month, in good ground. The tunnel will save 13 miles of travel.

The New York and Brooklyn tunnel bill has been introduced in the Assembly at Albany. The bill provides for a tunnel under the East River, from Greenwich and Morris Sts., in New York, to Smith St. and Atlantic Ave., Brooklyn. The capital named is $15,000,000.

The Hyde Park water tunnel is recommended by the finance committee of Chicago councils for extension one mile further out into the lake.

Crude oil for fuel has been adopted, it is reported, at the city water-works pumping station at Detroit, and at the north side station of the Minneapolis city water-works. At Detroit natural gas has been used for some months, but is now to be replaced by oil, which, it is stated, will be furnished by the Standard Oil Co.

The cession of arid lands to the several states is urged in a recent memorial to the U. S. Senate. The memorial was framed by the committee appointed for that purpose at the Salt Lake Irrigation Congress of Sept. 15 to 17, 1891, and of which A. D. Foote, of Boise City, Ida, is Secretary. It recites the resolutions adopted at Salt Lake and comments upon them at some length. At least four bills have already been introduced at this session of Congress providing that the arid lands shall be ceded to the several states and one bill affecting Idaho only has been introduced.

The Trinidad pitch-lake concession, says Governor Robinson of that island, has been extended for an additional year on the original term of 21 years from Feb. 1, 1909, for every $20,000 paid by the concessionaires before Feb. 1, 1909, over and above the minimum sum of $700,000 payable in the first 14 years, and the $140,000 to be paid for the 7 years' extension from Feb. 1, 1902. The Trinidad Asphalt Co. had also agreed that if, by Feb. 1, 1892, it had not paid to the colonial government $500,000, in addition to the $50,000 permanent deposit in London, the company would give to the Crown a mortgage on all land it now possesses in Trinidad as collateral security for the balance then remaining of the $700,000. Gov. Robinson complains in his report to Lord Knutsford that many persons are still illegally obtaining from government land or shipping from private land to which they have no title inferior asphalt which injures the reputation of Trinidad asphalt in New York, or it has to be purchased by the Barber Asphalt Co. to prevent it being laid on American streets. Gov. Robinson asks the Home Government to aid him in stopping this.

The East River bridge bill of the Union Elevated Ry. Co., of Brooklyn, has passed the New York Senate and is now before the Governor. This bill provides for two bridges, one crossing at Williamsburg and the other crossing from Fulton St., Brooklyn, to Delancey St. and the Bowery, New York. The bill also permits the erection of not more than three miles of elevated railway, in New York, to connect with this bridge. The capital is $25,000,000. The bill was strongly opposed on the ground that it exempted the company from any payment for the charter. It is to pay no taxes on the bridge proper and only on the approaches after ten years, and pays no percentage of its receipts to the cities of New York or Brooklyn. Tolls will be charged on all parts of the bridge.

STEAM TURBINES.

The ordinary method of using the pressure of steam to obtain power is to admit it into a closed cylinder, where it presses on a piston; and this method has become so familiar that it is often accepted without question as the sole possible method of developing power from steam.

Many engineers, even, are probably unaware that steam motors are in use which are made without cylinders, pistons or valves, and are able to run at a speed far beyond that of the most rapid turning electric motor, with an economy of the working fluid which has been shown by test to compare by no means unfavorably with that of good steam engines of modern design.

It is curious to note how often we find in the history of industrial progress that an idea which has been rejected for good reasons at one time is brought forward long afterward, when changed conditions permit its successful reduction to practice, and is then found to be of great value. In the case of steam motors, those of which we have the earliest record operated by the reaction of the steam issuing from tangential jets, as in the "Æolipile," often called "Hero's steam engine," which consisted of a hollow ball, free to revolve on trunnions, and having arms which delivered tangential jets of steam, the reaction of which rotated the ball. Its principle was the same as that of "Barker's Mill," illustrated in text books on physics.

Within a very few years inventors have turned their attention again in this direction and have attempted to utilize the inertia of jets of steam issuing at high velocity from a closed chamber to perform useful work. Instead of using the plain reaction wheel, however, they have followed the example of the hydraulic engineers and have adopted the turbine. It is a well known fact that turbine waterwheels cannot be satisfactorily used under high heads, largely on account of their rapid increase of speed as the head increases, and their low efficiency at high speeds. With the steam turbine, however, while the speed is far greater than that of any water turbine, the efficiency does not necessarily decrease with the speed, and may even be greatest at very high speeds. The endeavor of inventors, however, is to secure high efficiency at moderate speeds.

From a practical standpoint, the chief characteristics of the steam turbine are, first, high speed, from 3,000 to 25,000 revs. per minute; second, very great power with a minimum of weight and space occupied; third, fuel economy, rivaling in this respect steam engines of large size. One record before us to which we shall refer farther on, shows an efficiency of about 25 lbs. of steam at 95 lbs. pressure per effective HP. per hour.

The two steam turbines at present best known are the Dow turbine, invented by Mr. J. H. Dow of Cleveland, O., and the Parsons turbine, made by C. A. Parsons & Co. of Newcastle-on-Tyne, England. The Dow turbine is not yet on the market, and work with it is still in an experimental stage. The Parsons turbine has been pushed with much business skill and several hundred have been put in service.

The principal difference between the two motors lies in the way in which the steam is "compounded." The so-called steam turbine is in each case a number of turbines so connected together that the steam after passing through one recovers its velocity by its property of expansion and passes through the next, and so on, constantly falling in pressure, until it makes its exit from the exhaust pipe at a pressure but little above atmospheric. In the Dow motor the successive turbines are arranged radially, so that the steam enters at the shaft and is discharged at the circumference. In the Parsons motor the turbines are placed along the central shaft; the steam enters at one end and moves parallel with the shaft to an exit at the opposite end, actuating the blades of the successive turbines in its passage. The Dow turbine is much more compact, developing a far greater power for a given weight and space occupied. The Parsons turbine, on the other hand, operates at much slower speed, although we believe Mr. Dow intends to adapt his turbine also for low speeds.

The Dow turbine was first publicly described in a paper read by the inventor before the Civil Engineers' Club of Cleveland, Oct. 8, 1889. A motor which he then exhibited weighed 68 lbs., and had developed 10 HP., with a steam consumption of 47 lbs. per HP. hour, the steam pressure being 70 lbs. It was used at different times to run an elevator at 21,000 revolutions per minute, and a dynamo furnishing current for 13 arc lights, at 16,000 to 17,000 revolutions per minute, the speed being reduced by gearing in each case.

The gearing which ran at this remarkable speed was cut by Warner & Swasey, of Cleveland. The

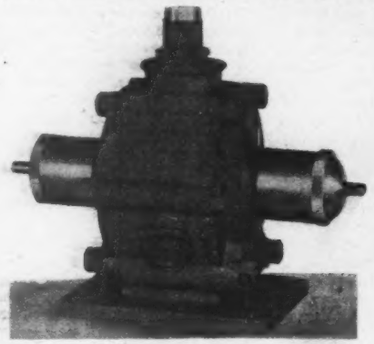


Fig. 1. Dow Steam Turbine of 25 HP. Weight, 105 lbs.

pinion on the motor shaft was 1 in. in diameter and it was placed between two 12 in. gear wheels of bronze with shrouded teeth. The pinion was made of rawhide, which worked very well until the heat from the steam softened it, when a vulcanized fiber pinion was substituted. It seems safe to believe that this is far the highest speed at which gearing has ever been used to transmit any considerable amount of power.

This motor was also used to drive a special design of rotary pump, the shafts of the two machines being directly connected, at a speed of about 10,000 revolutions per minute. It was estimated (just how is not stated) that in doing this work the motor developed 20 HP. with less than 27 lbs. of wet steam per HP. hour. The highest measured speed attained by the motor was 35,000 revs. per minute (= 583 per second). The diameter of the turbine disks was 5¾ ins., and at this speed the outer circumference traveled nearly nine miles per minute. The weight of the moving parts of the motor was 7 lbs. 7 oz. The main shaft was ⅝ in. in diameter.

Fig. 4. Enlarged Section, Showing Steam Passages in Dow Turbine.

Of course, the high speed at which this motor works is a disadvantage rather than otherwise for ordinary work, as it has to be reduced by gearing. A special use to which the motor has been successfully applied, however, is the propulsion of the flywheel which drives the Howell submarine torpedo. This flywheel weighs 132 lbs., and is 13.8 ins. in diameter, with 6¼ ins. face. It is made of forged steel and balanced with the greatest nicety. Before firing the torpedo it is set running at a speed of 10,000 revolutions per minute, and the power thus stored in it is utilized for the propulsion of the torpedo after launching. The Dow turbine is capable of bringing this flywheel to full speed in 2¾ minutes with 70 lbs. of steam. If the turbine develops an average of 20 HP. in this work, the energy stored in the flywheel would be about 91,000 ft. lbs., or enough to raise it to a vertical height of nearly 700 ft.

The Dow turbine used for this work is shown in Fig. 1, which is reproduced from a photograph. Its dimensions are: base, 8 by 10 ins.; body, 8¾ ins. diameter, 5 ins. length; total weight, 105 lbs. With 100 lbs. steam pressure the motor develops 27½ HP., and it is believed that as much as 40 HP. would be developed with 150 lbs. steam pressure. This motor was on exhibition at the Providence Convention of the National Electric Light Association a year ago.

The interior contruction of the Dow turbine is remarkably simple. Fig. 2 is a vertical section perpendicular to the shaft, and Fig. 3 is a longitudinal section. The rotating parts are ruled darker than the stationary parts in Figs. 3 and 4. As seen by Fig. 3, steam enters at the top and passes downward to an annular chamber surrounding the shaft. The turbine passages where the steam does its work lie between the plates (W) and (F), there being thus a turbine on each side. Both the fixed plates (F) and the rotating wheels (W) have their faces turned in alternate tongues and grooves. The tongues on one disk engage with the grooves in the other, but without touching, the tongues being much narrower

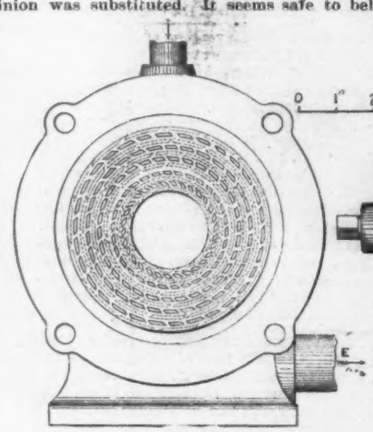


Fig. 2.

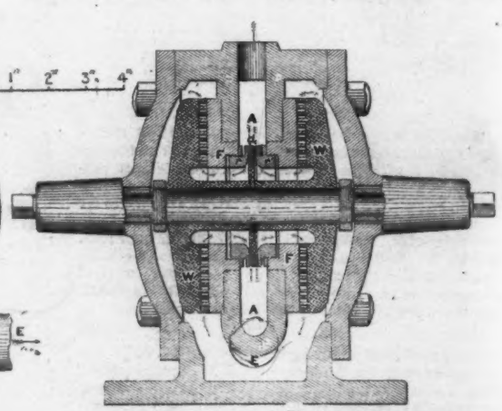


Fig 3.

SECTIONAL ELEVATIONS OF THE DOW COMPOUND STEAM TURBINE.

than the grooves. Across the tongues of the fixed disks inclined slots are cut to form passageways for the steam; and across the tongues of the wheels similar passages are cut in a contrary direction to form surfaces on which the steam may impinge and drive the wheel. The arrangement of the passages may be understood by reference to Fig. 2, and is still more clearly shown in the enlarged section, Fig. 4, which is intended to give merely an idea of the general arrangement of the passages across the stationary and the moving disks.

The passages of the stationary disks have a larger area of discharge than the passages through the tongues on the moving disks. Thus the steam expands and gains in velocity in passing through the stationary passages and imparts its energy successively to each of the concentric rings on the moving wheel, each of which may be considered as a separate turbine.

It will be noticed also that the total area of the passages increases from the center outward, thus giving as much facility to the movement of the steam after it has expanded and decreased in pressure as it has when it first enters the inner turbine at boiler pressure.

One of the most ingenious features of the motor is the manner in which an equal supply of steam is insured to each turbine, and friction between the tongues and the bottoms of the grooves is prevented. The wheels (W), (W) have long hubs, and at the center between the end of these hubs a plain circular disk (d) is clamped. In each of the fixed disks (F), (F

is screwed a ring (r), (r^1) projecting toward the moving disk (d). The narrow circular openings between the disk (d) and the rings (r), (r^1) form the steam ports for the turbines. It will be seen that an endwise movement of the shaft and wheels, say to the left, will move the disk (d) toward the ring (r), throttle the flow of steam to the left-hand wheel, and increase the flow to the right-hand wheel. Between the tongues and the bottoms of the grooves a very small space is left, about .0025 in., thus each of the wheels (W), (W) is pressed outward by the steam. The throttling of steam supply to the left-hand wheel reduces the pressure upon it and increases the pressure upon the right-hand wheel. This alteration in pressure, however, tends to force the moving parts back to the right, toward their central position, and thus maintain an equal steam supply to the two wheels. So perfect is this automatic regulation that with only .005 in. end play, there is said to be no wear on the ends of the tongues or bottoms of the grooves.

While the motor is thus automatically balanced against end motion, the circular form of all moving parts provides for its balance against centrifugal action. All the moving parts may be finished with the most perfect mechanical exactness, leaving difference in density of the metal on different sides of the wheel as practically the only cause of vibration.

It is of interest to note further the points in which this novel motor avoids the defects of the ordinary type of steam engine. In the ordinary engine it is well known that one of the principal causes of loss is the cooling of the high-pressure steam by its admission into the cylinder which but an instant before has been full of exhaust steam. In a single-cylinder high-pressure engine using steam at 100 lbs. and exhausting into the atmosphere, the difference of temperature is 128°, a difference more readily appreciated by remembering that it is the same as the difference between 86°, the temperature of a midsummer day, and 40° below zero, the freezing point of mercury. In this steam turbine, however, as seen in Fig. 3, each successive ring of metal is all the time exposed to steam of the same temperature. There is no chance for "condensation and re-evaporation." Again, the whole machine is jacketed with exhaust steam and the inner walls of the fixed disks are exposed to live steam, which fills the space (A),(A). Even the cooling effect of the exhaust steam jacket can be modified by covering the outer surface of the wheels (W), (W) with non-conducting material, if it is found worth while.

Again, the ordinary engine loses more or less steam by leakage past valves and pistons. In this motor the sole opportunity for the steam to pass from the entrance port to the exhaust port without doing work is through the narrow openings between the ends of the tongues and the bottoms of the grooves. This could probably be almost wholly obviated by turning fine grooves on the point of each tongue.

Still further, in the ordinary type of engine about 10% of the power developed is used up in overcoming the friction of valves, pistons, connecting rods, etc. In this motor, the force is applied directly to the shaft, and that without side strain or end thrust of any sort.

On the other hand, the friction of the steam itself in its passage through the motor is probably much greater than in the common type of engine. Necessarily the steam must escape at high velocity through contracted passages in order to perform its work. To what extent this friction can be reduced by changes in the form of passages remains to be seen.

In his paper before the Civil Engineers' Club of Cleveland the inventor of this motor said:

> The power of the steam turbine is explained by the principle that a jet of steam blowing into a vacuum will throw its whole energy into momentum. If, therefore, a turbine could be made which would utilize the entire momentum of the steam jet, it would be equal in efficiency to a theoretically perfect piston engine. But the extreme lightness of steam compels a greater speed of motor than has ever been successfully used, and the elasticity of steam, as contrasted with the non-elastic nature of water, compels the compounding of the steam turbine, though compounding the water turbine would destroy its efficiency. The momentum of the steam, though checked by the first series of buckets, recovers itself instantly by expansion, and must be checked again and again by successive series of buckets until the steam has spent its expansive force.

The advantages claimed for this compound steam turbine are: Extreme simplicity, compactness, lightness and cheapness, freedom from friction, and perfect steadiness of pull with consequent smoothness of action; also extraordinary storage of power in the momentum of the steam wheels, about 10,000 ft. lbs. in the 10-HP. motor, giving unusual steadiness under sudden changes of load. The turbine may use the highest steam pressure with advantage, for its normal speed under high pressure dense steam does not greatly exceed the speed required for the rarer steam of low pressure. . . . Nearly all the tests which I have made have been comparative, not absolute, but by their aid I have improved the motor, little by little, to ten-fold its first efficiency. Without doubt it may and will be further improved.

The Parsons Turbine.

The steam turbine invented by Hon. Chas. Algernon Parsons, Assoc. M. Inst. C. E., antedates considerably the Dow turbine. At the International Inventions Exhibition held in London in May, 1885, one of the Parsons turbines was exhibited driving a dynamo, which furnished current for 100 Swan incandescent lamps of 20 c. p. each, thus generating about 12 HP. The Parsons turbine in all its forms differs from the Dow turbine in that the steam moves parallel to the main shaft instead of in a radial direction. Fig. 5 is a section of the Parsons turbine as originally manufactured. Steam enters at the center, and moves to the right and left to an exit at each end. The outer casing carries stationary guide blades, and the shaft carries vanes against which the current of steam impinges. The number of compoundings is much greater than in the Dow motor,

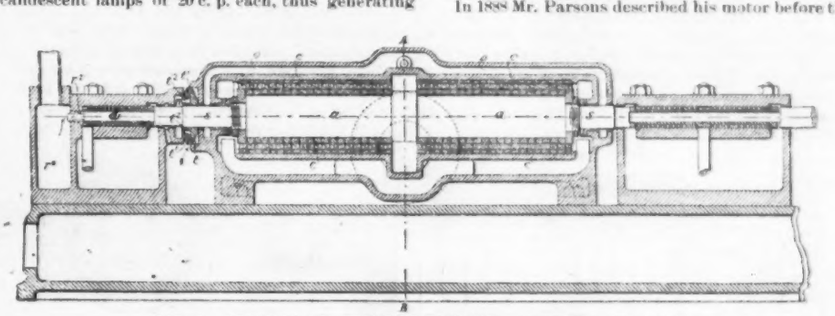


FIG. 5. SECTION OF PARSONS TURBINE AS FIRST INTRODUCED.

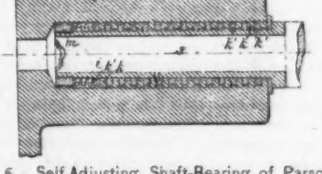


Fig. 6. Self-Adjusting Shaft-Bearing of Parsons Dynamo.

some of the Parsons turbines having been built with 45 turbines on each side of the center. The increase in volume as the pressure falls is provided for by increasing the depth of the blades toward the ends, and changing their pitch so that they are more nearly parallel to the axis of the shaft.

Of course the moving parts were made as accurately as possible; but to avoid all vibration the inventor applied to the motor an ingenious form of bearing which is well worth examination by designers of high speed machinery. The principle of this bearing is that the rotating body is left free to rotate around its center of gravity instead of being compelled to turn on the geometrical center of its shaft and thus generate an unbalanced centrifugal force. Fig. 6 illustrates one of these bearings. Upon the shaft is a thin bush (l), which is supported in the box by a series of thin washers. The alternate washers (K),(K), etc., fit the bush snugly, but have a play of say $^1/_{50}$ in. in the box. The remaining washers fit the box snugly but are bored $^1/_{50}$ in. large for the bush. Friction between the surface of the adjacent washers is secured by a spiral spring, tightened by the nut (M). The resistance of this friction holds the shaft in position unless a considerable force is exercised, when it will move to such a position that the rotating parts of the motor revolve about their center of gravity.

Of course a motor so far outside the ordinary was received with great incredulity. The standing of its inventor, however, and of the firm which first undertook its manufacture, Messrs. Clarke, Chapman & Co., of Gateshead-on-Tyne, was such that the motor was pushed into practical service, finding especial favor for marine electric lighting by virtue of its compactness and simplicity. By the spring of 1887 the total number of Parsons motors in use aggregated over 1,200 HP. The first large installment on shore was the electric lighting of the Newcastle exhibition of 1887. For this work 17 combined motors and dynamos were provided, with a combined capacity of about 480 electrical HP. Tests were made before the installation of this plant in presence of a committee of the exhibition managers, which showed a steam consumption of 65 lbs. per E.HP. Remembering the losses in engine friction and belt transmission, and in the production of electricity in the dynamo in a plant of the ordinary type, it is seen that this corresponds to perhaps 45 lbs. per indicated HP. in an ordinary steam engine.

In 1888 Mr. Parsons described his motor before the Northeast Coast Institution of Engineers. We quote from his paper as follows:

> The efflux of steam flowing from a vessel at 15.6 lbs. per sq. in. absolute pressure, through an orifice at 15 lbs. absolute pressure, is 366 ft. per second; the drop of pressure of 0.6 lb. corresponding to an increase of volume of 4%. The whole 45 turbines are so proportioned that each one, starting from the steam inlet, has 4% more blade area or capacity than that preceding it. Taking the pressure at the exhaust end to be 15 lbs. absolute, that at the inlet end will be 69 lbs. above the atmosphere. The steam enters from the steam pipe at 69 lbs. pressure, and in passing through the first turbine it falls 2.65 lbs. in pressure, its velocity due to the fall being 366 ft. per second and its increase of volume 3.85% of its original volume. It then passes through the second turbine, losing 2.55 lbs. in pressure, and gaining 3.85% in volume, and so on until it reaches the last turbine, when its pressure is 15.6 lbs. before entering and 15 lbs. on leaving. The velocity due to the last drop is 366 ft. per second. The velocity of the wheels at 9,200 revs. per minute is 150 ft. per second or 39.9% of the mean velocity due to the head throughout the turbines.
>
> Comparing this velocity with the results of a series of experiments made by Mr. Jas. B. Francis on a Tremont turbine at Lowell, Mass., it appears that there should be an efficiency of 72% if the blades be equally well shaped in the steam and in the water turbine, and that the clearances be kept small and the steam dry. Further, as each turbine discharges without check into the next, the residual energy after leaving the blades is not lost, as it is in the case of the water turbine, but continues into the next guide blades and is wholly utilized there; this gain should be equal to 3 to 5%.
>
> As each turbine of the set is assumed to give 72.5% efficiency, the total number may be assumed to give the same result, or, in other words, over 72% of the power derived from using the steam in a perfect engine, without losses due to the condensation, clearances, friction and such like. A perfect engine working with 90 lbs. boiler pressure and exhausting into the atmosphere would consume 20.5 lbs. of steam per hour per horse power; a motor giving 70% efficiency would therefore require 29.29 lbs. per HP. hour. The best results hitherto attained have been 52 lbs. of steam at 90 lbs. pressure per electrical HP. per hour [corresponding to about 36 lbs. per indicated HP.], but it is anticipated that higher results will be obtained shortly. [An expectation which will be seen below to have been realized.]
>
> Among the advantages of the motor is the increased life of the lamps, due to the uniform rotation of the dynamo. At the Phœnix Mills, Newcastle, an installation of 150 Edison-Swan lamps has been running on an average 11 hours a day for two years past; yet in that time only 94 lamps have failed, the remaining 65 being in good condition after 6,500 hours service. Now, if the lamps had only lasted 1,000 hours, on the average, the renewals

would have amounted to double the year's cost of fuel, as at present consumed.

About a year ago Mr. Parsons brought out a new type of turbine differing in very many respects from his original machine. A chief gain is the reduction of speed, which is brought down to about 4,500 revs. per minute against 10,000 to 13,000 in the old turbine. Fig. 7 shows longitudinal and cross sections of the Parsons turbine in its present form.

The turbine consists of fixed and moving rings of blades or vanes. The moving blades are mounted on disks on the central shaft. The steam flows up one side of the disk, round the edge and down the opposite side, then up the next disk, and so on. The sizes of the blades or vanes in the successive disks are so arranged that the steam expands progressively, and is exhausted from the last disk at a pressure corresponding to that of the atmosphere or of the condenser.

The end thrust of the moving shaft is not balanced as in the former style and in the Dow turbine, but is taken up by a thrust bearing. On the shaft (J),(J), Fig. 7, are arranged two series of inward flow turbine wheels (N') and (N''), differing in diameter from each other. These carry blades (F) of the shape shown in the cross section. The steam is caused to impinge upon these by the fixed guide blades (E), (E) attached to the rings (E'), (E'). The successive rings

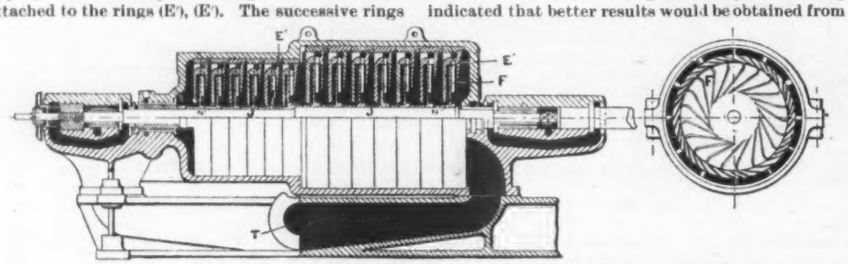


FIG. 7. PRESENT FORM OF PARSONS TURBINE

form a series of inward flow turbine chambers alternating with outward-flow passages. The driving impulse is given in each case on the inward flow, while the outward flow between the partitions conducts the steam from one turbine chamber to the next one. The live steam enters at the left, moves through the successive turbines, which it will be noticed increase in sectional area from left to right, and finally escapes into the exhaust passage (T). The division rings are carried very close to the bosses of the turbine wheels, and these bosses are kept as small in diameter as possible to decrease leakage. The division rings and the rings carrying the guide blades are made in halves and slipped into the half casings of the motor.

In place of the peculiar bearing described above, a simpler bearing has been adopted which secures the same end of permitting the shaft to rotate about its center of gravity and at a smaller cost. The bearing is inclosed within three concentric tubes, a space equal to the thickness of a piece of paper existing between adjoining tubes. These spaces are filled with oil, and form a cushion which prevents vibration being communicated to the framing.

Like the older type of Parson's turbine, this type of motor is put on the market directly connected to a dynamo, the two machines being mounted on a common bed plate. Tests of a combined turbine and dynamo of about 135 electrical HP. capacity were recently made by Prof. J. A. Ewing, of Cambridge University, and showed the remarkable economy of only 27.6 lbs. of steam per electrical HP. per hour, corresponding to perhaps 21 lbs. per indicated HP. hour. The steam used was 95 lbs. pressure, and a jet condenser attached to the exhaust end of the turbine gave a vacuum of 26½ to 28½ ins. This is the first attempt made to use a condenser in connection with the turbine.

The motor tested had turbine blades of the outward flow type, instead of inward flow, as described above. Besides tests of the machine at full power, it was also tested when giving an output of 10 per cent., 20 per cent., 30 per cent., etc., of its full capacity. The output was measured in kilowatts (1 kilowatt = 1.34 electrical HP.). The following table shows the steam consumption in pounds per kilowatt per hour for the several rates of working:

Kilowatts per hour.	Lbs. steam used.—Per K-W. hour.	Per HP. hour.	Kilowatts per hour.	Lbs. steam used.—Per K-W. hour.	Per HP. hour.
10	77.5	57.8	60	38	28.3
20	53	39.5	70	37.5	28.0
30	45	33.6	80	37	27.6
40	41	30.6	90	37	27.6
50	39	29.1	100	37	27.6

This reveals a fact of great importance, that the steam turbine, unlike the water turbine, does not decrease in efficiency in any marked degree until its load falls below half its full capacity. The bearing of this fact on the economic value of the turbine in ordinary service as a motor will be readily appreciated.

The weight of the turbine, dynamo and separate exciter was about 4 tons; it occupied a floor space about 3 × 14 ft. The machine was supported on three cast-iron pedestals, resting on an ordinary concrete floor. There were no holding down bolts or special foundations; and, though rotating at a speed of about 4,800 revolutions per minute, there was almost no vibration.

For some reason not given, the test was made under many disadvantages. The turbine was designed for steam of 140 lbs. pressure, but used only 90 to 95 lbs. pressure, and the steam pipe from the boiler to the motor was too small. It is true that these and other disadvantages noted by Prof. Ewing indicated that better results would be obtained from the motor under more favorable conditions; but the proper manner to make a test is to make the conditions right beforehand and give the thing tested a chance to do its best.

The work done by the motor-dynamo combination was measured by determining the voltage and current of the electricity generated. Great care was taken in standardizing the instruments used, and the measurements were checked in various ways. The steam was measured as feed-water and no deduction for entrained moisture seems to have been made. In part of the trials, however, the feed-water was not measured, but was estimated from the rise in temperature of the injection water. This slovenly feature of the test is also deserving of criticism, but even when allowance is made for errors in this respect, it remains certain that a remarkable economy was shown by the motor.

Prof. Ewing makes the following comparison between the record made in this test and that of engines usually used in electric lighting plants in England:

> For the sake of comparison it may be added that in a good ordinary compound condensing engine of corresponding power the consumption of steam is usually about 20 lbs. per indicated HP. per hour, which corresponds (allowing for necessary loss in transmission to the dynamo) to, say, 36 lbs. per K.-W. In the special type of single-acting high-speed engines made by Mr. Willans, and successfully used in many electric light stations, the consumption of steam at full load and at moderately full load is somewhat less. The best results in trials published by him show (with high-pressure and triple-expansion) a consumption equivalent to about 33½ lbs. per K.-W. in a non-condensing engine and 25 lbs. per K.-W. in a condensing engine worked at full load; while at half-load the numbers are about 43 lbs. per K.-W. and 32 lbs. per K.-W. respectively.
>
> I have no doubt that if it had been practicable in the turbine tests to use the full pressure of 140 lbs. per sq. in. for which the turbine was designed (in place of a pressure of 95 lbs.), that the consumption of steam per K.-W. would have been considerably reduced.
>
> As they stand, however, the results must be admitted to demonstrate a very remarkable performance. They show that in respect of economy of steam, and therefore of fuel, at full or moderately full load, the Parsons turbine of the type and size tested now challenges comparison with good engines of the usual kind, while its comparative freedom from friction gives it an exceptionally high efficiency when lightly loaded.

Apart from the question of steam economy, the lightness and compactness of the turbine-dynamo, its small first cost, the perfect ease with which it is started, its freedom from vibration and the absence of any need for heavy foundations, are points much in its favor as a generator for central station work.

Mr. Parsons has been good enough to give me every facility for examining the construction of his turbines and dynamos. I see no reason to anticipate that the charges for maintenance, for oil, and for attendance will be larger than in the case of other engines. I should rather expect them to be lighter; and this appears to be borne out by the experience of the Newcastle and District Electric Lighting Co., where turbine generators have been in use for about two years.

I had the advantage of seeing the plant at that company's station, and of obtaining particulars in regard to wages and other items of current outlay from the superintending engineer and the secretary of the company, who were most willing to supply information.

In regard to first cost, the turbine generator is probably cheaper, in large sizes, than any combination of ordinary engine and dynamo giving an equal output.

The turbine worked at its full load of 100 K.-W. per hour without any sign of distress, and so far as could be judged was capable of giving a greater output without difficulty.

In our editorial columns we have briefly commented on the prospects for the use of steam turbines, considering the success which has already been attained. They are one of the most interesting and one of the most remarkable of recent engineering developments. Those who desire to pursue the investigation of the subject further by examining all the scanty literature, which as yet exists, will find some notes on the theory of the steam turbine by Prof. J. B. Webb, in the Transactions of the American Society of Mechanical Engineers, Vol. X., p. 680; and Vol. XII., p. 888. See also Trans. Assoc. of Eng. Societies, Vol. VIII., p. 583; "Engineering Review" (London), July 6, 1891.; "Engineering (London)," Jan. 13, 1888, and Jan. 8, 1892.

The illustrations accompanying this article, which are not in all respects what we could wish, are reproduced with some changes from the two last named journals and "The Iron Age," and from a photograph sent us by Mr. H. P. Elwell, of Providence, R. I., general agent for the Dow turbine.

GERMAN PRACTICE AS TO COMPUTING BRIDGE STRAINS.

In our issue of Dec. 12, 1891, there appeared a discussion by Mr. J. A. L. Waddell on the relative merits and demerits of substituting uniformly distributed loads in place of concentrated wheel load, with some comments by this journal.

We are indebted to Mr. B. M. Wagner, of Fluntern, Zurich, Switzerland, for the accompanying engraving from a blue print issued by the Gotthard Railway to its engineers and bridge contractors. Mr. Wagner informs us that the same is in use, not only on the Gotthard Railway but on most, if not all, the Swiss railways, and adds:

> This diagram and practice is more or less a practical indorsement of the opinion expressed in the aforenamed article. The necessary calculations were made entirely

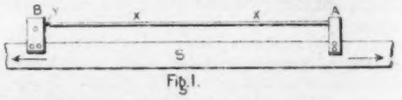


Fig. 1.

by graphic methods. In fact throughout Switzerland and in a large portion of Germany all bridge computations are made by the methods of graphic statics. These methods are so simple and complete that I cannot understand why they are not used to the exclusion of numerical computations to a greater extent in the United States.

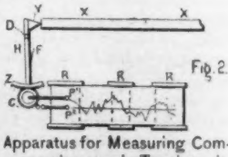


Fig. 2.

Apparatus for Measuring Compression and Tension in Bridge Members.

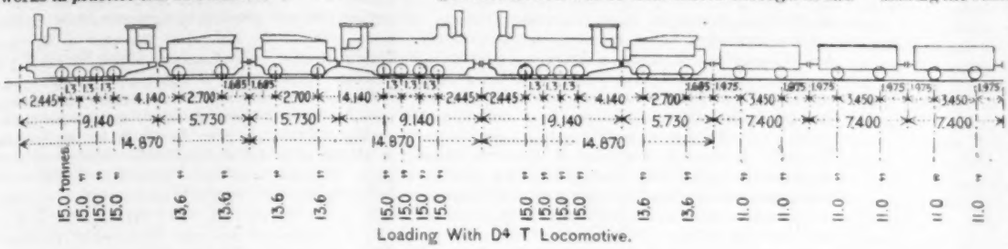
In the second portion of the same article reference is made to an apparatus for measuring the extension of bridge members under tension. Mr. Wagner writes us that not long ago he was shown and examined the instrument outlined in the accompanying sketch, which not only measures extension, but also compression. This apparatus was shown him by one of the government experts, who was very well satisfied with its working, and Mr. Wag-

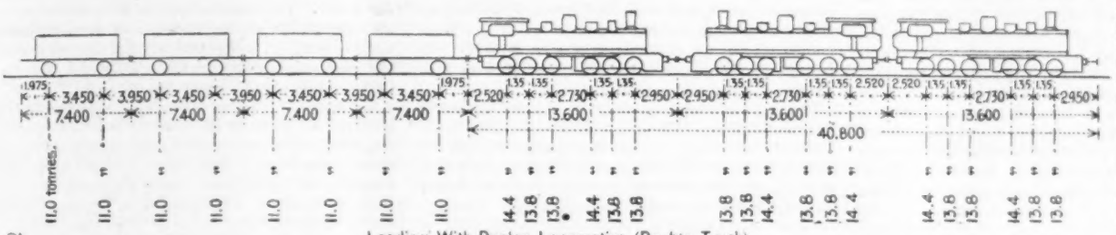
ner rightly surmises, we are sure, that it will interest our readers. Though the sketch is not to scale and merely shows the principle of the device, the latter is so simple that a pretty good idea of how it works in practice can be obtained.

In Fig. 1, S is the bridge member to be tested. A and B are clamped on by means of thumb screws. X X is a rod rigidly fastened to A, and at its other end in contact with point Y. In Fig. 2, D is a pivot on which lever H turns. F is a spring that presses on H, and thereby forces S to remain in contact with X X. Z is a toothed or cogged sector, C is a cogwheel in connection by means of lever attachment with the pencil P_1; P_2 is a pencil that is rigidly fixed. R R R are spools supporting a paper roll, which is moved by clockwork.

The mode of operation is as follows: A and B are clamped to the member to be tested, either for compression or tension; the bar X X is brought in contact with point S; the distance from center of it to center of B is measured. All other lengths are constant. Now if the clockwork of spools is set in motion, the two pencils P_1 and P_2 will mark two parallel straight lines. We have now only to wait for a train to come along. If the bar is thrown into tension X X will try to move away from S, and S will follow; and this motion will be transmitted through H and C to the movable pencil P_1, which will describe a line that will be above the line of P_2. Each wheel of the train as it passes will cause more or less of a jog in this line, and if the rate of rotation of the spools is known we have also the time interval.

This apparatus is the invention of Herr Fränkel, Dresden, and is manufactured by Herr Oscar Leuner, "Mechanisches Institut am Polytechnicum," Dresden, from whom fuller information can be obtained or the instrument purchased.

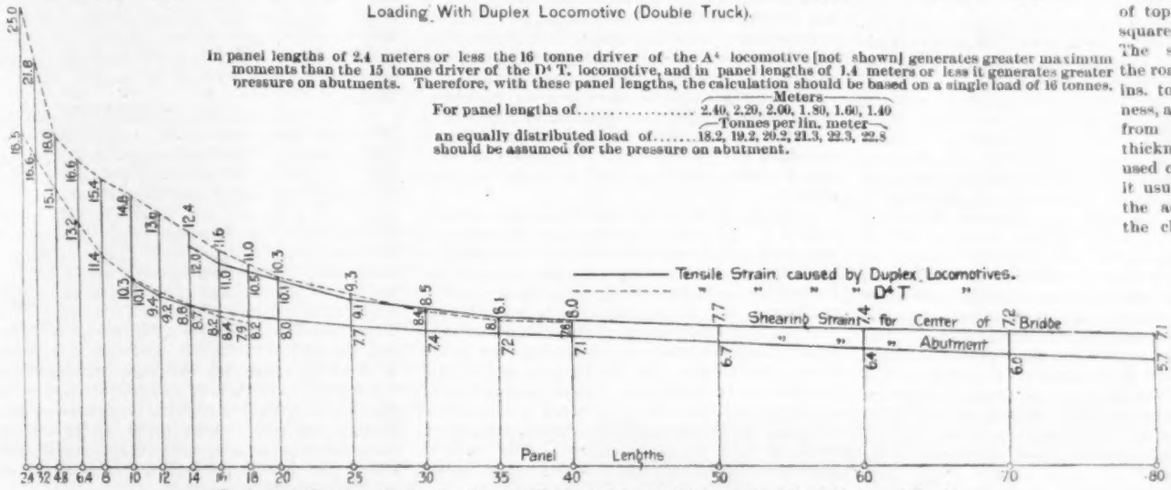




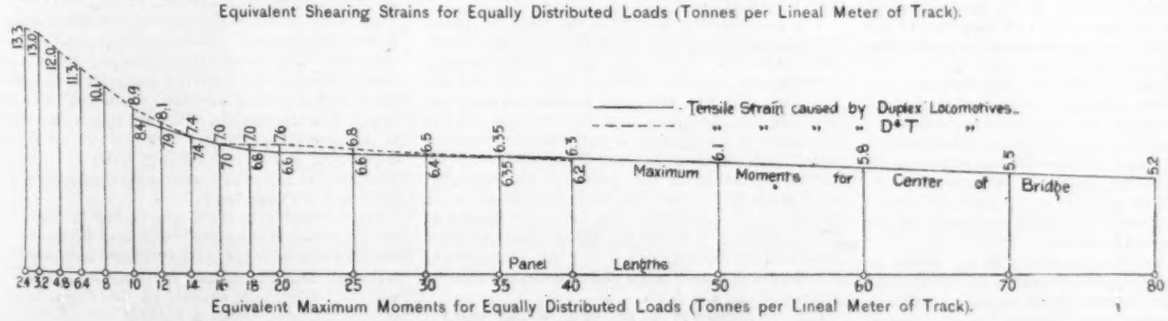
In panel lengths of 2.4 meters or less the 16 tonne driver of the A⁴ locomotive [not shown] generates greater maximum moments than the 15 tonne driver of the D⁴ T. locomotive, and in panel lengths of 1.4 meters or less it generates greater pressure on abutments. Therefore, with these panel lengths, the calculation should be based on a single load of 16 tonnes.

	Meters				
For panel lengths of.....	2.40,	2.20,	2.00,	1.80,	1.60, 1.40
	Tonnes per lin. meter				
an equally distributed load of.....	18.2,	19.2,	20.2,	21.3,	22.3, 22.8

should be assumed for the pressure on abutment.



Equivalent Shearing Strains for Equally Distributed Loads (Tonnes per Lineal Meter of Track).



Equivalent Maximum Moments for Equally Distributed Loads (Tonnes per Lineal Meter of Track).

STANDARD BRIDGE STRAIN DIAGRAMS, ST. GOTTHARD RAILWAY.

ROADMAKING IN AMOY, CHINA.

Mr. Edward Bedloe, U. S. Consul at Amoy, says the roads around Amoy are "admirable and kept in splendid condition." The main road of Amoy is about 30 miles long and the smaller roads and streets aggregate about 150 miles more.

These roads vary from 20 to 30 ft. in width and the center is raised about 1 ft. above the sides, with the rise increasing in proportion where the ground slopes. The edges are guttered or ditched. In making the roads on level surfaces a foundation of broken granite is first loosely laid with a gentle rise upward toward the center. On this is placed smaller pieces of granite, broken brick, earthenware and sometimes shells, and on this again is put a mixture of granite, sand, clay and lime, applied wet and well rammed. The proportions of the top dressing vary greatly as given below:

Sand, from 45 to 90%. Clay, from 36 to 50%. Lime, from 1 to 18%.

The sand, lime and a little clay are made into a stiff brown mortar by adding water, and this is then applied to the road. This mixture usually sets in 24 hours; but before it is set the remaining clay is thrown on and rammed down. There seems to be no fixed rule for the amount of top mixture to the square unit of area. The substructure of the road varies from 6 ins. to 1 ft. in thickness, and the top layer from 1 to 4 ins. in thickness. The stone used costs nothing, as it usually comes from the adjoining land; the cheapest lime is used, costing from 3 cts. to 5 cts. per "picul" of 135 lbs.; the common laborer receives from 10 to 20 cts. per day, and the foreman 30 cts. The cost of making such a road under these conditions is about 77 cts per sq. yd. Coolie labor is about half as effective as Caucasian labor.

The law requires the road to be kept in good repair, and the responsibility is placed upon the chief man of a village, the owners of adjacent property and the keepers of shops abutting on the roads.

As a rule, in China, the roads are simply mud roads, fair in the dry season, impassable, except on foot, in the wet season. The American Consul at Foo Chow, in his report on roads, simply says, "There are no roads in this part of China." In Ningpoo, nearly 40,000 sq. miles, there is not a wheeled vehicle of any kind. Everything is carried on the rivers and numerous canals, or on the backs of men over the country paths. These paths average 4 ft. in width, and are sometimes paved with slabs or round stone, with a "rest-house" built at intervals over the path. It might be added that Amoy lies in 24° 40' north latitude, and practically has only the wet season, between February and June, and the dry season. The annual rainfall is 46 ins., which falls in 445 hours in the wet season of about 100 days. The mean temperature is 70.7° F.

MUNICIPAL GOVERNMENT IN LARGE CITIES.

At the last meeting of the Boston Society of Civil Engineers, Mr. F. P. Stearns, President, the topic was the municipal government of large cities of the United States, and papers were read concisely outlining the practice in St. Louis, New York, Buffalo, Boston, Providence and Paris, France. In introducing the subject Mr. Stearns pointed out that in Boston $7,500,000, out of a total expenditure of $14,400,000 in the financial year 1890-91, was for the construction and maintenance of public works. This is omitting all interest, debt and sinking fund payment, and it shows that more than one-half of the total expenditure comes directly within the province of the civil engineer. The importance of selecting honest, competent and efficient men and of adopting a good system of government was then pointed out.

The first paper read, as reported in the "Boston Herald," was upon the methods of St. Louis, by Mr. Robert Moore. As we have given this paper in full in our issue of Jan. 23, 1892; we will not repeat it here. Mr. William Jackson, City Engineer, then outlined the system in force in Boston. Here the Mayor is the chief executive officer, and through the several officers and boards of the city he exercises the executive powers of the city. A board of 12 aldermen and 75 common councilmen is elected yearly, but the two branches sit and act separately, except when they meet in convention. The city council makes appropriations, levies taxes, authorizes loans, and may make such by-laws and ordinances as are legal for towns to make. They may provide by ordinance for the appointment and salaries of necessary officers; but the Mayor appoints the officers, except those holding office from the State, subject to confirmation by the board of aldermen. A school committee of 24 persons is elected by the people, 8 in each year. The finances of the city are cared for by the city treasurer, city collector, an auditor and a board of 6 sinking fund commissioners. Taxes are assessed by a board of 9 principal assessors, with 74 assistant assessors. A board of 12 overseers of the poor has charge of the "outdoor relief" of the poor, and a board of 3 commissioners of public institutions has charge of the house of correction, house of industry, house of reformation, city lunatic hospitals, and city homes for the poor and for neglected children. The city hospital is in charge of 5 trustees and a board of health of 3 persons exercises all the powers of the city relating to public health and city cemeteries. A city registrar keeps the records of births, deaths and marriages and issues certificates of intention to marry.

The police department is in the hands of three commissioners appointed by the Governor of the State. Three fire commissioners have charge of the fire department and supervision of all electric wires and business liable to cause fire. The Governor also appoints the fire marshal. An inspector of buildings has supervision over all buildings and issues permits for plumbing; but the city architect usually makes all contracts and has charge of all public buildings erected by the city. The superintendent of public buildings repairs and maintains all public buildings, provides furniture and has charge of the property in the city armories.

A board of surveys, consisting of 3 persons, to serve 3 years, was appointed in 1891 to make plans showing the location and grade of such highways as in their judgment are necessary for the present or future interests of the city. A board of 3 street commissioners has power to lay out, widen or discontinue highways and order specific repairs, subject to the approval of the city council when the cost exceeds $10,000. This body is also a board of appeal in cases of overassessment of taxes. The superintendent of streets has charge of the construction and maintenance of streets and sewers, the cleaning of streets and removal of ashes, garbage, &c. He makes all contracts and employs all labor necessary; places and maintains street and ward signs, sees that owners of buildings affix street numbers, and keeps a plan and record of the construction of sewers and a record of all sewer assessments. No person or other department can open a street for any purpose without his permission. He notifies departments and persons when he is about to open a street or repave it, and after such street is completed no permit can be granted for one year. Permits for sewer connection, for using part of the streets for coal-holes, vaults, etc., for laying wires, railway track, poles, etc., must also come from his office. As assistants the superintendent of streets has a secretary, executive engineer, purchasing agent and deputies having charge of paving, sewers, bridges, sanitary division and street cleaning.

A water board of three persons has the care, control and maintenance of all water, reservoirs, aqueducts, pumping stations and other property for the supply of water. This board constructs and maintains all pipe lines, furnishes and repairs water meters, and keeps a record of meters and fixes from time to time the tariff for the use of water. A water registrar assesses the rates and makes contracts for furnishing water. He causes, once each year, the premises of each water taker to be examined, and shuts off and turns on water.

A park commission of three persons has charge of all public parks, makes the by-laws and ordinances for the government of parks and appoints the park police. A superintendent of public grounds has charge of the Common, Public Garden and city squares.

The city engineer has charge of all the engineering work for the different departments (excepting the sewer division of the street department) and the construction of all public works of the city which properly come under the direction of a civil engineer, unless otherwise specially provided for. The city engineer makes such surveys as may be required by the several departments, excepting for the sewer division of the street department. He has the custody of all plans and surveys relating to the laying out, widening, extending and grading of streets.

Besides these officers there are the following: Corporation counsel, city solicitor, city printer, a record commission of two persons, charged with the collection and preservation of records and documents relating to the city, and a number of minor officers.

Of the above officers the street commissioners are elected by the people; all heads of departments, except the police commissioners, are appointed by the Mayor, and all subordinates are appointed by the heads of departments subject to the approval of the Mayor. The Mayor may remove any of his appointees from office for cause stated in the order of removal, and the heads of departments can do the same. The law does not require any professional qualification in appointees. The usual term of office of trustees or members of a board is three years from May 1, in the year of appointment, and until a successor is elected and confirmed. The term of persons having sole charge of a department is one year from May 1.

Public works are authorized by the city council, except in special cases, when the Legislature exercises its power. In theory, the ordinary running expenses and the minor public works of the city are paid from the tax levy, and permanent improvements of magnitude are paid for by loans, the city being authorized to incur a net debt, exclusive of water debt, of not more than 2% of its average assessors' valuation for the previous five years, but the Legislature in its discretion authorizes loans outside of the debt limit. The tax rate is limited to not exceed $9 per $1,000 of the average assessors' valuation for the previous five years, exclusive of the state and county taxes and of sums required on account of the city debt.

The government of the city of New York was explained in a paper written by Mr. F. M. Scott, Aqueduct Commissioner. The executive functions are vested in the Mayor and the departments, the latter mostly directed by boards of commissioners. The Mayor is elected for two years, and is removable by the Governor, for cause. The president of the board of alderman is also elected by the people for two years, and is in fact the vice-Mayor, exercising power in the absence of the Mayor. The Mayor appoints the heads of the following departments: Law, police, public works, public charities and correction, fire, health, public parks, taxes and assessments, docks, street cleaning and board of excise. Of these departments, those pertaining to law, public works and street cleaning are single-headed; the others are directed by boards made up of three or four persons. The heads of department hold office for terms of three, four or six years, and, except the commissioner of street cleaning and the board of excise, are removable by the Mayor, with the consent and approval of the Governor of the State. The street cleaning commissioner can be removed by the Mayor with the consent of the board of health, and the commissioners of excise are removable by the Governor. The Mayor can appoint officers without approval or confirmation by any person or official body, except in the case of the commissioner of street cleaning, where at least two members of the board of health must assent.

For the 23rd and 24th wards, or the annexed district, a commissioner of street improvements exercises the same powers as to streets as the commissioner of public works does in other parts of the city. This commissioner of streets is elected by the people of the two wards for six years, but is removable by the Mayor, The chief financial officer of the city is the comptroller, who is elected by the people for three years, and is removable by the Governor for cause. The comptroller receives and disburses all taxes and revenues, audits and pays all claims against the city, and prescribes the form of keeping the accounts, and has the right to inspect and revise the accounts of all the city departments.

The board of aldermen possesses very limited legislative functions, as the powers and duties of the city officers are very minutely prescribed by the statutes of the State. The board consists of 25 aldermen elected for one year. They have some power to adopt ordinances, which must be approved by the Mayor or passed over his veto. The board of health enacts ordinances for the preservation of public health, which have all the validity and force of penal statutes. The dock department can also pass similar ordinances relating to matters under its charge.

The Department of Public Works is presided over by a single commissioner, who is empowered to appoint a deputy. This department has cognizance and control (1) of all structures and property connected with the supply and distribution of Croton water; (2) of the collection of the revenue arising from the sale or use of Croton water; (3) of opening, altering, regulating, grading, flagging, curbing, guttering and lighting streets, roads, places and avenues; (4) of the repairing and construction of public roads; (5) of the care of public buildings; (6) of the filling of sunken lots; (7) of public sewers and drainage; (8) of street vaults and openings in sidewalks; (9) of paving, repairing and repaving streets and keeping the same clear of obstructions, and of the relaying of pavements removed for any cause; (10) of digging and constructing wells; (11) of the care, management and maintenance of the public baths; (12) of the location, erection, establishment and maintenance of public urinals.

The work of this department is divided amongst a number of bureaus. The only bureau as to the chief officer of which the law prescribes any professional qualifications is that having immediate charge of the structures and property connected with the supply and distribution of Croton water; this officer is designated the "Chief Engineer of the Croton Aqueduct," and it is provided by statute that he and his assistant engineer "must be civil engineers of at least 10 years' experience."

The sewer system of the city is also in charge of an officer known as the "engineer in charge of sewers," and he is always an engineer by profession, although his office is not specially designated by statute, having been created by the Commissioner of Public Works under a general law authorizing him to employ engineers, surveyors and other persons to devise, frame and construct a general sewerage system for the city. Except as above stated, no professional qualifications whatever are prescribed by law for the commissioner of public works, his deputy or any of the heads of bureaus in his department.

The deputy commissioner, chief clerk, consulting engineer, and the heads of bureaus are appointed by the commissioner at pleasure, without any examination save such as he may choose to make. All other positions in the department, save those of axemen, laborers and the like, are appointed by the commissioner after competitive examination by the examiners of the civil service board. All the regular clerks and heads of bureaus are protected from arbitrary removal by the general provision of the city charter, that "they may not be removed until they have been informed of the cause of the proposed removal, and have been allowed an opportunity of making an explanation." All employees other

than regular clerks and heads of bureaus are subject to removal at the pleasure of the commissioner, unless they were "veterans of the late war," in which case, by operation of a general state law, they can be removed only upon charges, for cause, and after trial.

The dock department, presided over by a board of three commissioners, and the park department, under the charge of four commissioners, have the custody, management and control of the classes of public works indicated by their respective titles.

There is no statute prescribing any professional qualification for any of the above-named commissioners, nor for any of their employees, although in all of these departments engineers are, of necessity, employed.

Generally speaking, all public work is awarded to the lowest bidder, upon sealed bids invited by advertisement. The head of a department may reject all bids and re advertise; but if he awards the contract it must be to the lowest bidder. The money necessary to pay for the work as it progresses is raised by the comptroller by the sale of assessment bonds which are redeemed out of the proceeds of the assessment when collected. Such public works as are not paid for by assessment are provided for either out of taxation, or out of the proceeds of bonds. In the former case, the amount of expenditure is limited by the appropriation therefor made by the board of estimate and apportionment; a board consisting of the Mayor, the comptroller, the president of the board of aldermen and the president of the tax department, and which has the power to fix the several amounts to be raised annually by taxation.

The amount of expenditure out of the proceeds of city bonds is in general limited by the act authorizing the issue of the bonds, for without an enabling act of the state legislature no city bonds can be issued for any purpose.

The cost of regulating, grading, paving, curbing and guttering of streets, laying of crosswalks, construction of sewers, fencing of vacant lots and a few other local improvements is assessed upon the property benefited. In case a street or avenue has once been paved and the expense thereof assessed upon the benefited property, the cost of any repaving which may be found necessary is paid out of general taxation, or out of the proceeds of bonds issued for the purpose.

Mr. J. Herbert Shedd, city engineer, sent in a paper upon the city government of Providence, R. I., of the following import:

The government of the city of Providence is organized as follows: Mayor, elected by the people by a majority vote; board of aldermen, one from each ward, elected by property voters and by plurality vote; common council, four from each ward, elected by property voters and plurality vote.

The city officers, with the exception of city treasurer, overseer of the poor, harbor master, commissioner of public works and city engineer are elected by the city council or board of aldermen. The city treasurer, overseer of the poor and harbor master are elected by the majority of the people. The commissioner of public works is appointed by the mayor and approved by the board of aldermen. The city engineer is appointed by the commissioner of public works.

The commissioner of public works, who is appointed by the mayor subject to the approval of the aldermen, has control of the public works department, which comprises the water-works, sewer, highway, bridge and city engineer's departments. The commissioner of public works has charge of the construction and maintenance of all work pertaining to these departments. The commissioner of public works appoints the city engineer and assistant engineers, the salaries of same to be fixed by the commissioner subject to the approval of the board of aldermen. The commissioner appoints all superintendents, inspectors and employees of the several departments, and fixes the salaries of same up to $1,000; above that sum the city council approves his recommendations. The commissioner has the power to advertise and contract for material or work to be done after the same has been ordered by the city council.

The appointees are not required by law to have any professional qualifications.

The term of office of the commissioner of public works is three years. The city engineer and his assistants' term of office expires with the commissioner's. The other employees of the public works department have no stated term of office. The office of secretary to the commissioner is created by the General Assembly, but the appointment and removal is under the control of the commissioner of public works.

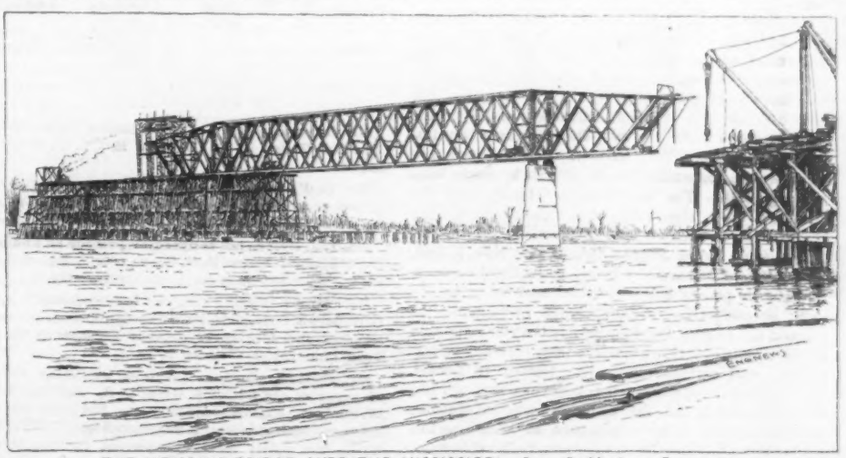
The construction work on highways, water works, sewers and bridges is performed by the commissioner of public works, acting under resolutions of the city council. The maintenance of repairs on highways, sewers and water-works are kept up without an order from the council. On bridges, a sum not exceeding $750 per year for each drawbridge and $500 per year for other bridges is allowed for maintenance. An ordinance of the city council is necessary to exceed that sum. The city council provides each fiscal year an appropriation for every department. In water-works and sewers an appropriation for both construction and maintenance is provided. In bridges, highways and city engineer's department one appropriation is made. An addition to an appropriation is obtained by an ordinance of the city council, the funds being taken from unexpended money in the treasury.

The money for the support of the city government is obtained by taxation on real and personal property, water rents, court fines, licenses, interest on deposits, rents from city property, etc. The city of Providence is allowed, by statute, to borrow money by notes or bonds to an amount not to exceed 3 per cent. of the city's valuation, and can only borrow in excess of that amount by permission of General Assembly of the state. The resolutions of the city council ordering work performed generally state that the same shall be done in accordance with the plans and specifications of the city engineer.

[To be continued.]

THE MEMPHIS BRIDGE.

The accompanying view, for which we are in debted to Mr. George S. Morison, Engineer, shows the condition of the work on Nov. 29, 1891. As we shall shortly give a full description of this notable and interesting structure, an outline description of which has already appeared in these columns, we will only repeat now that the structure consists of two spans of 621 ft. 0½ in., and one span of 790 ft. 5 ins., which we need hardly say are the longest truss spans ever erected, with the sole exception of the Forth bridge. The bridge, according to charter, stands 75 ft. above high water, which latter is nearly 34 ft. above low water at this point. The incomplete span towards the right is the 790-ft. span, which consists of two cantilever arms 169 ft. 4½ ins. each and a central span of 451 ft. 8 ins. A continuous 621-ft. span occupies the center of the view, and beyond it, in process of erection, is a second cantilever span, also of 621 ft.

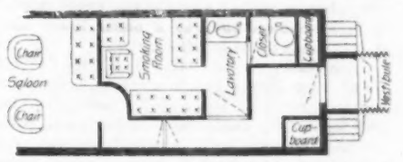


THE MEMPHIS BRIDGE OVER THE MISSISSIPPI; Geo. S. Morison, Engineer.
(Condition of Work on Nov, 29, 1891.)

Levee appropriations to the amount of $15,000,000, to be expended in five years, have been approved by the U. S. Senate Committee, of this amount $10,000,000 would be expended on the lower Mississippi River and $5,000,000 above the mouth of the Ohio River.

FROM NEW YORK TO BALTIMORE AND WASHINGTON BY RAIL.

In going to Baltimore to attend the meeting of the American Institute of Mining Engineers, a report of which meeting is given elsewhere in this issue, the train taken was the "Royal Blue" express, leaving Jersey City at 11.42 a. m., and running over the Central Railroad of New Jersey to Bound Brook, 31 miles; the Philadelphia & Reading R. R. to Philadelphia, 60 miles; and the Baltimore & Ohio R. R. to Baltimore, 96 miles, the total run being 187 miles. By the courtesy of Mr. J. H. Olhausen, General Superintendent of the the Central R. R. of New Jersey, the ride of 91 miles to Philadelphia was made on the engine, which was a Philadelphia & Reading R. R. eight-wheel engine with Wootten firebox, and



Plan of end of "Royal Blue" Line Parlor Car, showing arrangement of Smoking Room, etc.

the dimensions of which are given below. The train consisted of two passenger cars next the engine, weighing 70,000 lbs. each a parlor car weighing 74,000 lbs.; and a combined dining and baggage car weighing 80,000 lbs.; a total train load of 294,000 lbs. The dining saloon accommodates 24 persons, having three tables on each side. The parlor car is finished in mahogany and upholstered in light grey or dove color. The smoking room of this car is well arranged, being quite shut off from the main part of the car, and also separated from the lavatory and closet, as shown in the accompanying cut, the black lines on which represent partitions. The ordinary cars have the Hale & Kilburn seats, and each has a smoking room and lavatories. The cars are all 65 ft. long, and are connected by vestibules. The cars for all the Royal Blue trains were built by the Pullman Palace Car Co., and are heated by steam and lighted by the Pintsch compressed gas system. They are supposed to be painted the color known as royal blue, but most of them are so dark as to appear almost black, although some cars seen at the yards at Baltimore and Jersey City had the bright blue color indicated by the name.

As already stated the train was hauled from Jersey City to Philadelphia by a Philadelphia & Reading R. R. eight-wheel engine. Leaving Jersey City at 11.42 a. m., stops were made only at Elizabeth, 11.58 a. m. and Wayne Junction, 1.20 p. m., the train reaching Philadelphia (24th and Chestnut Sts. station) at 1.34 p. m., 1 minute late. If the train is over 4 minutes late, the engine driver and fireman have to report and give an explanation. The coal supply in the tender was not good, the greater proportion being very dirty, and as a consequence, after passing Bound Brook the fireman had hard work to keep up the pressure. The regular working

boiler pressure is 145 lbs. per sq. in., but beyond Bound Brook it gradually fell to 100 and 95 lbs. There is no hood or cab over the footplate of the tender, and the steam gage for the fireman is placed in an awkward position on top of the firebox, between the end of the firebox and the cab. Owing to the large amount of grate area and the combustion chamber formed by the bridge wall, there was very little smoke, and the long trail of clean, white steam was most refreshing to see, as a change from the usual dirty clouds of smoke and steam. The engine is very steady on the track, and no unpleasant jerking or lurching motion is felt in the cab. The tender, however, owing to its lighter weight, is not very pleasant to ride on. Between Elizabeth and Wayne Junction there is a straight ride of 74 miles, but in taking water at the track tanks the train was slowed down to a much lower rate of speed than is usual on other roads.

From Jersey City to Bound Brook, the Central R. R. of New Jersey has four tracks, ballasted with broken stone. The two middle tracks have heavy rails spliced by angle bars, 30 ins. long, with six bolts. The two outer tracks have lighter rails spliced by angle bars 24 ins. long with four bolts. The joints are broken and suspended. As far as Bergen Point the line is protected by the automatic electric block signal system described in our issue of March 29, 1890. From Bound Brook to Philadelphia the Philadelphia & Reading R. R. has a double track road, with good track, well ballasted with broken stone. The rails are laid with broken, suspended joints, spliced by long angle bars and six bolts. Along this line are peculiar revolving target signals mounted on towers resembling lighthouses. The signal consists of a vertical cylinder with three radial wings, forming three wide targets, about 4 ft. wide, painted red, white and green respectively. A portion of the cylinder forms the middle of each target and has openings fitted with glass of corresponding colors for the night signals. The cylinder revolves on its vertical axis, being turned by a man in the tower; the cylinder and wings are about 6 ft. high.

At Philadelphia, a Baltimore & Ohio R. R. eight-wheel engine was attached and took the train on to Baltimore, stopping only at Wilmington, Del. The engines for this service are of great size and power, and have driving wheels 6 ft. 6 ins. in diameter. On this division the track is ballasted mainly with gravel, which is covered over the middle of the ties. There is also some rock ballast. The rails are laid with broken suspended joints, spliced by angle bars and four bolts. The new standard track, and the standard track signs, etc., of the Baltimore & Ohio R. R., have been described and illustrated in Engineering News, July 18, Oct. 31 and Nov. 7, 1891. The cuts and fills are of a loose, gravelly character, and are in places badly washed and worn by the rain, necessitating frequent work in repairs. At Canton the engine and four cars were run upon one of the tracks of a three-track steam transfer or ferry boat, and carried across the harbor to Locust Point, Baltimore, where the line runs through the streets and ends in the Camden terminal station. Another engine is here attached at what was the rear of the train to take the train on to Washington. This ferry and dead end arrangement will be avoided when the new Belt Railway (Eng. News, Dec. 12, 19, 1891, and Jan. 2, 1892) and terminal station are completed. One of the old camel back engines was seen in the yard at Baltimore. These engines have eight wheels, all coupled, and the cab is perched on top of the boiler, the firebox sloping down from the rear of the cab. In bridge work the Baltimore & Ohio R. R. is using through plate girders up to 102 ft. with double track and 94 ft. with single track. Riveted Warren girder deck spans are used up to spans of 110 ft. The bridge floors are of ties 8 × 8 ins., spaced 12 ins. c. to c., giving a clear spacing of 4 ins.; the guard timbers are 6 × 8 ins., 7 ft. apart. For bridge ties Georgia yellow pine is being used, although rather more expensive than oak, as it does not warp and split so much as oak. The ordinary ties are of mountain oak, cut along the line of the road.

The trip to Washington was made over the Baltimore & Potomac R. R. (Pennsylvania R. R. system), by the train leaving the Union Station, Baltimore, at 8:27 a. m., and arriving at Washington, 43 miles, at 9:45 a. m. The return trip was by the train leaving Washington at 5:40 p. m., and arriving at Baltimore at 6:40 p. m., making no stops. New rails are being laid on this division, spliced by long angle bars and six bolts. The ballast is of gravel, except at the track tanks, where broken stone is used. The line is equipped with the Pennsylvania R. R. system of signals. Each car of this train was heated by two stoves. The ordinary day cars were very well appointed and very comfortable.

The return trip from Baltimore was made by the Royal Blue train leaving the Camden station of the Baltimore & Ohio R. R. at 8:50 a. m. and making several stops. The train consisted of 6 cars: 1 express car, 1 baggage and smoking car, 2 day cars, 1 parlor car, and 1 through sleeping car from southern points. It was hauled to Philadelphia by one of the big eight-wheel engines above referred to, the dimensions of which are given below. Philadelphia was reached at 11:26 a. m., 16 mins. late, the run of 96 miles being made in 2 h. 36 mins., and in one place three consecutive miles were made in 55 secs. each. From Philadelphia to Jersey City the train was hauled by a Philadelphia & Reading eight-wheel engine, with Wootten firebox, as already described. On this run the fastest mile noted was made in 53 secs., and several miles were made in 55 to 60 secs. each.

The following are the leading particulars of the two classes of eight-wheel engines used on this trip:

	P. & R. R. R.	B. & O. R. R.
Cylinders	18½ × 22 ins.	20 × 24 ins.
Diam. of driving wheels	5 ft. 8 ins.	6 ft. 6 ins.
" of truck wheels	2 " 9 "	3 " 0 "
" of boiler	4 " 10 "	4 " 10 "
Form of boiler	Straight.	Wagon top.
Form of firebox	Wootten.	.....
Size of firebox	114 × 96 ins.	107 × 33⅜ ins.
Boiler pressure	145 lbs.	140 lbs.
Tubes, number	336	251
" diam. outside	1⅝ ins.	2 ins.
" length	9 ft. 2¼ ins.	11 ft. 10 ins.
Grate area	76 sq. ft.	.....
Heating surface, tubes	1,212 sq. ft.	1,544.90 sq. ft.
" " firebox	205 "	143.45 "
" " total	1,417 "	1,687.45 "
Driving wheel-base	7 ft. 0 ins.	7 ft. 6 ins.
Total "	21 " 1 ins.	21 " 11 ins.
Weight on driving wheels	71,950 lbs.	76,000 lbs.
" truck	31,900 "	40,000 "
" total	102,850 "	116,000 "
" of tender	70,000 "	.....
Capacity of tender, water	3,500 galls	3,500 galls.
" of " coal	12,000 lbs.	.....
Brakes	Westinghouse automatic for drivers, tender and train.	

PERSONALS.

Mr. Oscar Edwards has been elected President of the Vermont Valley R. R. Co., vice Mr. A. B. Harris, deceased.

Mr. O. F. Nichols, M. Am. Soc. C. E. and Chief Engineer of the Brooklyn Elevated Ry., has been made a Member of the Institution of Civil Engineers, of London.

Mr. T. J. Hyman has resigned his position as Auditor of the Wisconsin Central R. R. Co. to accept that of Assistant to the President of the Great Northern Ry. Co.

Mr. Alfred Walter, General Superintendent of the Baltimore & Ohio R. R. lines east of the Ohio River, has accepted the position of General Manager of the New York, Lake Erie & Western R. R.

Mr. John W. Sanborn has been appointed General Manager of the Boston & Maine R. R., and Mr. Daniel W. Sanborn, Superintendent of the Southern Division, has been appointed General Superintendent. These officers divide the duties formerly assumed by the late Mr. Furber, as General Manager.

Mr. E. M. Reed, M. Am. Soc. C. E., Vice-President of the New York, New Haven & Hartford R. R., died in New York, Feb. 13. He was born in 1821, became Master Mechanic of the New Haven, Hartford & Springfield R. R. in 1848, and General Superintendent of this road and the New York & New Haven R. R. when they were consolidated in 1872. He was appointed Vice-President in 1874.

Mr. McLeod, President of the Philadelphia & Reading R. R., has made the following appointments: J. Rogers Maxwell, First Vice-President, with office in New York; Chas. Hartshorne, Second Vice-President, in charge of the finances of the company; Robt. H. Sayre, Third Vice-President, in charge of construction and maintenance of way; John Taylor, General Traffic Manager; Henry S. Drinker, Assistant to the President, all with offices in Philadelphia.

Mr. William L. Saunders, Secretary of the Ingersoll Sergeant Rock Drill Co., of this city, is a candidate for the office of Mayor of the borough of North Plainfield, N. J. He graduated as a civil engineer in 1876 from the University of Pennsylvania, and was engaged for several years in difficult submarine work near this city, from which he went to his present office with the company, whose affairs he has administered with ability for ten years. Mr. Saunders is a member of the American Society of Civil Engineers and is well and favorably known on account of his published researches on compressed air.

NEW PUBLICATIONS.

NEWBURG (N. Y.) WATER SYSTEM. Report by John D. Van Buren, C. E. 8vo., pamph., pp. 32; 11 tables.

This report contains a description of the present water works, a very elaborate statistical study of available supply based on drainage area, rainfall and past consumption; a discussion of the improvement of the quality of the water and recommendations which are now being carried out at an estimated cost of $135,000, and which have been noted in our construction news columns.

ADDITIONAL WATER SUPPLY FOR ROCKFORD ILL. By Engineers J. T. Fanning, D. C. Dunlap and D. W. Mead. 8vo., pamph., pp. 29 and ten appendices of text and folding tables, three plates.

This report contains some very interesting information regarding the five artesian wells from which the city draws its supply; the consumption of water at Rockford; results of geological studies in Northern Illinois and Southern Wisconsin, accompanied by a map and profile; analyses of water from the Rockford wells, from several other artesian wells and from other sources. The committee found three of the Rockford wells in evident need of repacking and advised that this be done. It also recommended for an additional supply that a 10-ft. shaft lined with iron or brick be sunk 80 or 125 ft. in depth, and that from the bottom of this shaft seven wells be sunk 200 ft., diverging from the vertical at the rate of 4 ins. per ft. These wells would reach into the St. Peter sandstone. If after tests and analyses these wells were not successful the committee advise that additional wells be sunk into the Potsdam rock, the level of the present wells. A 42 × 100-ft. stand-pipe and new mains are recommended. At present direct pumping is used.

WATER STATISTICS OF NEWBURG, N. Y. Reports of Consulting Engineers, Extracts from Reports of Superintendents, Data from Water Commissioners' Reports, Soundings and Temperatures of Lake, etc., etc. 8vo., pamph., pp. 58.

This compilation covers the period from 1852 to 1890 and includes such matter as it was thought would be of value in deciding upon a new source of supply.

REPORT ON THE CHARACTER OF THE PUBLIC WATER SUPPLY OF NEWPORT, R. I. By T. M. Drown, M. D. 8vo., pamph., pp. 26; 8 illustrations; one folding table.

The results of Prof. Drown's investigations show that the water furnished the city is liable to contamination from the drainage area and rendered objectionable by shallow flowage. On Dec. 5, 1891, actual measurement showed that at the upper end of Easton's Pond there was uncovered 290,000 sq. ft., or 4.8 acres, of black, slimy mud. Plats are given showing the location of farm buildings very near and draining into Easton's Pond and its feeder. The water-shed of this pond has a population of 118 per sq. mile, with about 300 cattle per sq. mile in addition. The Croton water-shed is said to have a population of 69 to the sq. mile, with 91 cattle. Prof. Drown states that in order to secure a safe water supply for Newport a strip of land 200 or 250 ft. in width should be secured around the ponds and on both sides of the feeders, and that the bottom of the feeders, and that the bottom of the ponds should be cleaned of mud and excavations be made to prevent shallow flowage. He adds that this will be so expensive that the company cannot be expected to do it and that the city should own the works. The report is accompanied by sanitary analyses of 20 samples of water. The bacteria determinations in these analyses were made under the direction of Prof. T. Sedgwick and the microscopic analyses by Mr. G. N. Calkins.

PROPOSED NEW WATER-WORKS OF KANSAS CITY, MO. Report to the Board of Public Works made by Hydraulic Engineers Chas. Hermony, G. H. Benzenberg and M. L. Holman. 8vo., pamph., pp. 23.

This report was made in October last, and its recommendations were noted in our news columns at that time. The city is now supplied by a private company but has voted bonds to the amount of $2,000,000 for new works. The Commission recommended a direct pumping system with water pumped to settling basins and repumped to the mains.

ANNUAL REVIEW OF IRRIGATION. The "Irrigation Age" for Feb. 1, 1892. Published monthly by Smythe, Britton & Poore, San Francisco, Salt Lake City and Denver. 4to, pp. xxviii., 88; 25 cts.

The February number of the "Irrigation Age," contains, besides other valuable matter, a very exhaustive review of irrigation progress in the United States during 1891. This publication is so notable, and contains so much matter of interest to our readers that we depart from our usual practice and review the periodical in these columns.

The review for the United States as a whole has been compiled by R. J. Hinton, of Washington, D. C., and for the several States and Territories by prominent engineers and irrigationists. Mr. Hinton is Special Agent in charge of the Irrigation Inquiry now being carried on by the U. S. Department of Agriculture, and his position gives him special facilities for reviewing the year's progress, which has been notable. Mr. Hinton estimates that the total area under irrigation in the United States in 1891 was 18,583,000 acres, and the area under cultivation

for 1891, 8,049,000 acres. In addition works under construction or soon to be begun will put some 6,000,000 acres more, it is estimated, under ditch. Mr. Hinton's review occupies three pages of the "Age," and is accompanied by a reproduction of a photograph of the author.

The review by states occupies 40 pages and is illustrated by many views from photographs, several maps, detail and other drawings. The value of these articles will be partly shown by stating their authors, as follows: Arizona, by Lincoln Fowler; California, by George F. Weeks; Colorado, by L. G. Carpenter; Kansas, by J. W. Gregory; Montana, by William F. Wheeler; Nebraska, by Lewis E Hicks and A. B. Wood; New Mexico, by E. F. Hobart; Nevada, by C. W. Irish; Idaho, by A. D. Foote, I. N. Hart and W. A. Goulder; Oregon, by F. H. Brigham; Utah, by Calvin Reasoner; Washington, by L. F. Howlett; Wyoming, by P. L. Naismith.

"Irrigation Law" occupies about three pages, Mr. Hinton contributing to this department also, and Mr. C. C. Wright, author of the Wright Irrigation District Act of California, discussing California Irrigation Districts under the title, "Irrigation on Popular Principles." "The Model Laws of Wyoming" are outlined by Mr. P. L. Naismith, who also wrote the review of irrigation in Wyoming.

Irrigation in Australia is reviewed by Mr. R. J. Hinton. Irrigation in Africa, Europe, South America and Mexico, is discussed by Will Hall Poore. Mr. F. H. Newell writes of the work done in connection with irrigation by the U. S. Geological Survey.

The "Publisher's Department" includes some 15 pages of illustrated reading matter, much of which is of interest to engineers.

As a whole, this annual review of irrigation is undoubtedly the most complete and valuable summary of irrigation progress in the United States which has ever been published, as would be expected from the writers named. Future annual reviews are promised by the "Irrigation Age," and if on a par with this one, and they doubtless will be, they will be looked for by all interested in irrigation. We shall have more to say regarding this number of the "Age" in a later issue.

SOCIETY PROCEEDINGS.

AMERICAN INSTITUTE OF MINING ENGINEERS.

The annual meeting was held at Baltimore, Md., Feb. 16 to 20. The headquarters were at the Rennert House, where, on registering, members were presented with cards of admission to the Walters Gallery, a noted private collection of works of art, and with a very interesting and instructive "Guide to Baltimore," prepared by the local committee for the use of the Institute. This book gave particulars of the public institutions and manufacturing industries of the city, the geology of the city and vicinity, and contained a map of the city and geological maps of the district. The sessions of the meeting were held at Johns Hopkins University.

At the opening session, in the evening of Feb. 16, there were brief and appropriate addresses by Mr. Jas. W. Tyson, Chairman of the Local Committee; Hon. F. C. Latrobe, Mayor of Baltimore; and Mr. D. C. Gilman, President of Johns Hopkins University. These addresses were responded to by the President, Mr. John Birkinbine, in a humorous speech, but the regular presidential address was deferred in order to leave more time for the special paper of the evening. The Secretary, Mr. R. W. Raymond, then read the list of names of candidates for membership, and announced the deaths of Mr. Edward Nichols and Dr. T. Sterry Hunt, which have already been noted in our columns. An interesting paper on "The Mining of Gems and other Minerals in Hungary, Bohemia and Russia" was then read by Mr. Geo. F. Kunz, and was illustrated by lantern views of the country, the mines, etc. The paper referred more especially to the mineral resources and industries of the Ural Mountain region in Russia. This region has extensive iron mines, which are open air workings like quarries, worked in benches. Platinum is also mined, and gold on a small scale. There are also great and rich deposits of gems and precious stones of various kinds. The paper described briefly the author's journey, the people and the towns, the character of the deposits and methods of working, etc. It was incidentally stated that the steamers on the river Volga use petroleum for fuel. After the reading of the paper, the party adjourned to a lower room, where a case of specimens of precious stones, cut and in the rough, was on exhibition, and where by invitation of Mr. Gilman, President of the University, a pleasant informal social meeting took place, during which refreshments were served.

At the morning session on Feb. 17 the first paper presented was by Mr. H. M. Howe, on "The Copper Mines of Vermont." The formation consists of gossan iron ore at the surface, with undecomposed sulphides below, while between the two is a rich ore containing in some places 30 to 60% of copper. The lenses of copper ore have been traced to great depths. Some of the pyrite mines are worked for the sulphur, for sulphuric acid. Mr. H. B. C. Nitze then read an abstract of his paper on "The Magnetic Iron Ores of Ashe County, N. C." These deposits are as yet almost unworked, owing to their inaccessibility. The ores are principally magnetites, chemically suitable for the manufacture of Bessemer pig iron; they are generally of good quality, low in sulphur, and below the Bessemer limit in phosphorus. The mined material will in many cases be rich in silica, but a high grade product may be obtained by means of magnetic concentration. There is an extensive belt of titaniferous ore, but the percentage of titanic acid condemns this material for blast furnace use, at least in competition with iron ores less difficult to smelt. The discussion on this paper referred mainly to the extensive deposits of titaniferous ore in the United States, which ore contains so much titanic acid that it cannot be used for blast furnaces. Such ore has been discovered on the Midland Railway (Wilmington & Weldon R. R.), in North Carolina, which contains 40 to 43% iron, 14% titanic acid, and is low in silicon. Dr. Raymond referred to deposits in New Jersey, and stated that several members had suggested the use of a movable hearth, a proposition which Mr. Howe thought feasible and worth experimenting with in view of the enormous deposits. Mr. Birkinbine stated that the Lake Champlain ores are more or less titanic, and that the idea of a movable hearth process for such ore had suggested itself to him. An immense supply of ore would be offered to any one perfecting a method of utilizing titaniferous ore with a low fuel consumption and a small amount of labor. Some of this ore shows considerable reduction of titanium in the magnetic separator, nearly 70% of titanium being reduced in one case.

Mr. W. H. Hoffman then read a paper on "Granulating Magnetic Iron Ore with the Sturtevant Mill," which is a rotary mill in which the pieces of ore are ground by being violently thrown against one another. He said that in order to make this process pay it is necessary to treat at least 450 tons per day of 20 hours. The ore cannot be packed too closely, if moderately dry, and the mill will deal with even railway spikes and other foreign matter which will pack and interfere with roller mills. The bushings are 23½ ins. outside diameter and 16 ins. deep, and the wear amounts to ⅛ in. to ⅝ in. per day of 20 hours with roasted ore. One man can attend to three mills, employing an ordinary laborer whenever necessary to change a bushing, the time of which averages 1 to 1½ hours. The cost of operation is less than with crushers. A strong blast is used to draw off the ground product. The proportion of dust is 8%, but this is treated in a separator, and the proportion of dust finally blown off is only 5%. Mr. Birkinbine referred to the necessity for an efficient machine for drying ores which come from the mine too wet for the screen or separator.

Mr. Uike read a brief paper on a new mineral which he had discovered in South Dakota, and which he proposed to call cuprocassiterite. He remarked that there is doubt as to how the ancients obtained their bronze, and suggested that possibly veins of this mineral had been worked in prehistoric times. A paper by Mr. F. W. Gordon, "Notes on the Selection of Iron Ores, Limestones and Fuels for the Blast Furnace" (Eng. News, Feb. 20), was then read by title.

The Secretary then read an abstract of a paper by Mr. E. C. Moxham on "The Great Gossan Lead of Virginia." This deposit, now assuming economical importance, belongs to a belt not confined to Virginia, and to a type or class which is represented at Sudbury, Canada; Litchfield Conn.; Anthony's Nose, on the Hudson River; Lancaster Gap, Pennsylvania, and Ore Knob, in North Carolina. Deposits of this class have been chiefly deemed valuable hitherto for copper, and occasionally for nickel, but the gossan outcrop overlying the deposits was mined in the early days of iron ore. The deposit is a great continuous vein of "mundic," or the undecomposed iron sulphide (comprising both pyrite and pyrrhotite). The gossan is the product of the oxidation of the mundic, forming a cap or covering of brown iron ore. It is 12 to 40 ft. wide at the surface, 50 to 70 ft. wide at the bottom, where it joins the mundic, and 40 to 175 ft. below the surface. It is as yet being mined in only two places, the output being but 800 to 1,000 tons per day, but the importance of the mines is already being realized, and nearly every furnace within 250 miles uses from 25% upward of its mixture from this source. It is an excellent ore to mix with the other ores of the district, and is said to give strength to the iron, and to be easily reduced, thus promoting economy in fuel. It is low in silica, and the proportion of iron, calculated on the original weight, including moisture, is from 40 to 48%. The discussion on this paper turned largely on the roasting of ore to drive off the sulphur. Dr. Egleston stated that this is done successfully in Europe, but in order to make it pay, labor must be both cheap and skilled. Swedish iron ore is sent to Germany to have sulphuric acid, gold, etc., extracted, and the residue is oxide of iron, which is used for making a good quality of iron. The iron must be kept at the point of fusion, but must not reach it, as otherwise the product will be worse than the original. It does not pay on a large scale. Dr. Raymond remarked that it is impossible to do the work in mechanical furnaces, as they have no discretion. The men must watch the material carefully, and keep stirring it to prevent the formation of material in the interior. It was further stated that gossan ore being really a sponge, holding 80% of water, operators should mine in the summer, house the output and stop winter mining.

The afternoon session was devoted entirely to papers and discussions dealing with the phosphate resources of the United States, a subject which has been treated of in Engineering News, July 11, 18 and 25 and Oct. 17, 1891. Mr. George H. Eldridge read a Paper on "Southern Phosphate Deposits," referring mainly to Florida. These Florida deposits include land rock phosphate, soft phosphate, land pebble phosphate and river pebble phosphate. The two former belong to the eocene and miocene limestone formations and the two latter to the recent formations. The proportion of phosphate of lime averages 80% in the rock, 70% in the land pebble and 60% in the river pebble phosphates. Mr. T. M. Chatard then read a paper on "Phosphate Chemistry as it Affects the Miner." He said that sellers know that the value of their product depends upon chemical analysis and the proportion of lime phosphate thus shown, with deductions for alumina, oxide of iron, etc., if they exceed certain points, but they have to rely entirely upon chemists' analyses for these determinations. Chemists for such work should be chemical engineers, and not mere analysts, and should use uniform methods of making analyses, as at present too much depends upon the man and his special methods. The secretary then read brief extracts of the following papers: "Laurentian Low-Grade Phosphate Ores," John Stewart; "Association of Apatite with Beds of Magnetite," and "Contributions to the Early History of the Industry of Phosphate of Lime in the United States," both by Mr. W. P. Blake. A paper by Mr. W. R. Phillips, giving a list of minerals containing at least 1% of phosphoric acid, was read by title. Mr. W. B. M. Davidson then read "Notes on the Geological Origin of Phosphate of Lime in the United States and Canada," in which he expressed the opinion that the various deposits had their origin as follows: Canada; The phosphoric acid was secreted by animal agency in sedimentary beds, afterward subjected to heat and pressure, causing folding, and the apatite crystallized out in pockets caused by the folding. Carolina; The phosphate beds are sedimentary estuarine deposits, brought in suspension by an ancient river which flowed through a district of Vicksburg limestone, exposed to decay and denudation, the water probably carrying large quantities of carbonate of lime in solution. The presence of fossils is due to the preserving action of the phosphate of lime, and the phosphoric acid in the beds is not derived from the bones, but much of that in the bones is derived from the beds. Florida; The geological conditions of Florida and some of the West Indian Islands are identical, and the boulder rock is derived from the leaching of the limestone the material being washed into hollows and caves and deposited by water, while the limestone walls have since been washed away during subsidence. Mr. D'Invilliers then presented a short description of the phosphate mines at Navassa. Mr. W. H. Morris read a paper on "Phosphate Slags," referring to the successful use of this material as a fertilizer. It is made, not from blast furnace slag, but from converter slag, at a temperature of nearly 3,000°, and is ground very fine. The manufacturers guarantee a certain percentage of sulphuric acid. Mr. Egleston said that some years ago he had successfully experimented with feldspar, ground to an impalpable powder and used as fertilizer.

At the evening session Mr. Spencer Miller described the Lidgerwood system of elevated cableways or ropeways as applied to phosphate mining, illustrating his paper by lantern slides. The special features of the plant as used for such work are the use of the Elliott smooth rope and the ready portability of the conveyor plant, the cables having turnbuckles at each end, and the towers being merely A frames. The carriers, hauling and special devices, etc., were described in detail. The plant as a whole is of a similar character to that used for heavier work, as at the Sodom dam, New York (Eng. News, Dec. 1, 1888); at the Austin dam, Texas (Eng. News, Nov. 14, 1891) and at the Tilly Foster mines, New York (Eng. News, April 20, 1889). Several improvements have been introduced in the more recent plants. Mr. James Gayley then read a paper on "The Preservation of the Hearth and Bosh Walls of the Blast Furnace," describing various bosh coolingplates, including one of his own design. He also described the formation of carbon material to the depth of over 2 ins. on the exposed end of the firebricks, which led to experiments in the use of carbon brick for the hearth and bosh walls. The bricks are made of graphite and clay, coke and clay, and coke and tar, and the experiments have resulted very satisfactorily. This paper was also illustrated by lantern views, and it was followed by some general discussion on blast furnace practice.

Mr. W. H. Morris then read a brief paper on "The Control of Silicon in Pig Iron," in which he said that for the basic Bessemer process, using ores low in silicon as far as possible, he has made iron which was below 0.4% silicon and 0.05% sulphur. The best week's work averaged 0.25% silicon and 0.05 sulphur. He has made a great deal of iron below 0.10% silicon, and even down to a trace, in which sulphur did not exceed 0.017%, and has also run the phosphorus as high as 4.5%. In the discussion some particulars were given of the regular manufacture of iron with a wonderfully low proportion of silicon.

The report of the scrutineers of the ballot for officers for the ensuing year was then read. The officers are as follows:

President, John Birkinbine, Philadelphia, Pa.; Vice-Presidents, Thomas M. Drown, Boston, Mass.; David T. Day, Washington, D. C.; John Stanton, New York, N. Y.; Managers, H. L. Hollis, Chicago, Ill.; George W. Goetz, Milwaukee, Wis.; Charles Kirchhoff, New York, N. Y.; Treasurer, Theodore D. Rand, Philadelphia, Pa.; Secretary, Rossiter W. Raymond, New York, N. Y.

On Feb. 18 the members and guests, including a number of ladies, went to Annapolis on a special train over the Baltimore & Ohio R. R. and Annapolis & Baltimore Short Line R. R. After a visit to the Capitol, where some lobbyists, or members of the "third house," were anxious to know if the "delegates" needed any legislation, the party proceeded to the U. S. Naval Academy, where there was much of interest to be seen in the way of guns and gun fittings, machinery, marine models, etc. A point learned here was that the screw propellers of variable pitch which are to be used on the new United States cruisers are only variable when the ship is out of the water, the variation being effected by means of slotted bolt holes for the blades. Devices for varying the pitch of the screw while the ship is at sea are not considered to be sufficiently perfected as yet to be reliable. The kitchen and mess room arrangements were specially interesting to the ladies, and much interest was shown in the cadet parade for dinner. After the round of inspection the members and guests proceeded to the Executive Mansion, where they were tendered an informal reception and entertained at luncheon by Governor Brown and Mrs. Brown. This was a very pleasant affair, and was thoroughly enjoyed and appreciated by all present. The special train left Annapolis on the return trip at 3 P. M., arriving at Baltimore 4:15. In the evening a banquet was held at the Rennert House. This was well attended, and the arrangements were very well carried out. After the dinner there were several speeches made, most of which were humorous, and all of which were very well received.

On Feb. 19 the party made an excursion by steamer. The first stop was made at the works of the Chesapeake Pottery Co., where the manufacture of ornamental ware was followed, from the rough clay to the burning, glazing and decorating of the finished articles. Specially prepared souvenir plates were presented by the company. The next stop was at the Baltimore Copper Smelting Works, where the various processes were followed, from the treatment of the raw ore to the casting of pigs and ingots and the final rolling and cutting of beautifully polished copper plates. Some miniature copper ingots were distributed as souvenirs. The steamer then proceeded to the works of the Maryland Steel Co., at Sparrows Point, lunch being served during the trip. These works were established by the Pennsylvania Steel Co. as a branch of its works at Steelton, Pa., and are now owned and managed by the Maryland Steel Co., which was organized in 1891, and is controlled by the same interests as the former company. A train of flat cars fitted with seats had been provided, on which the party were carried from point to point, thus saving much unpleasant walking. The company has two deep water piers for the steamers which bring the ore from Cuba and Spain. There are four blast furnaces, the blowing engines for which have blowing cylinders 7 ft. diameter and 5 ft. stroke. The Bessemer plant is designed for four 18-ton converters, and two converters are now in operation. The blooming mill is of the "two-high" reversing type, with 36-in. rolls. The rail train is "three high," with 26-in. rolls driven by two Porter-Allen engines. This train is equipped with tables for mechanically handling the rails for the different passes, and can turn out rails 180 ft long, or six rail lengths each. Beyond this are the saws, straightening tables, and drills for the splice bolt holes. The foundry is fitted with hydraulic cranes, and a 50-ton electric traveling crane is being built for this shop. A large planer in the machine shop was taking dry cuts on a connecting rod head, no soap suds or other cooling medium being used. The marine department is now building a side wheel steamer 210 ft. long and a screw steamer 305 ft. long, both of steel. The souvenirs distributed here were rail sections.

So much time was spent in going over these extensive works, which were specially interesting on account of their modern construction, having only been commenced in 1887, that there was no time to stop at the Columbian Iron Works (to see the United States cruisers now being built there), the Rasin Fertilizing Works, or the oil refineries at Canton, as had been intended. Many members desired to leave on evening trains and a brief meeting was therefore held on board, which was the formal closing of the annual meeting.

On Feb. 20 a number of members went to Washington by a special car attached to the 8.27 a. m. Pennsylvania R. R. express. Most of them got off at the navy yard station, and went direct to the U. S. Navy Yard, where they embarked on the Government tug "Triton" for a trip to the proving grounds at Indian Head, 24 miles down the Potomac. The grounds and the work done there are under the entire charge of Ensign Dashield, U. S. N., who made the visit one of special interest. The standard navy 4-in. rapid fire gun was examined, as well as the 6-in., 8-in. and 10-in. ordinary guns, light Hotchkiss rifles, etc., and the various devices and instruments used in recording the pressure of the charge, the flight of the projectile, etc. The ingenious breech mechanism of the heavy guns was particularly noted. Shots were fired from the rapid fire gun and the 6 and 8-in. rifles. The 6-in. conical shot passed through one of the 6-in. Carnegie nickel steel armor plates, which was tested some time ago (Eng. News, Nov. 28, 1891). This exhibition shot broke off a large section of the plate, by extending a crack which had been developed since the plate was tested, thus showing the structure of the metal and its compacted nature round the shot holes, caused by the compression by the shot forcing its way through. Samples of smokeless and ordinary "cocoa" powder were exhibited, and specimens secured. After a very interesting visit, the party returned to the navy yard, and spent a short time inspecting the large new gun shops. These shops are well equipped with traveling cranes and with powerful machine tools, among the most interesting of the latter being the lathes and rifling lathes for the large 6 in. to 12 in. guns. Guns of various sizes were seen in various stages of construction, from the main tube and rough jackets to the finished articles, bored, rifled and turned to a beautiful exterior bright finish. At the navy yard gates the party separated, some remaining in Washington or starting thence for other places, while a few returned to Baltimore on the Pennsylvania R. R., by the 5.40 p. m. train. This ended a very pleasant annual meeting, and one which had been successful in every way, while the arrangements made by the local committee for the entertainment of members and guests and for the various trips and excursions were attended with great success and were thoroughly appreciated by the visitors.

THE INSTITUTION OF MECHANICAL ENGINEERS.

[From our London Correspondent.]

The annual general meeting was held on the evenings of Feb. 4 and 5. The papers read were: "Notes on the Mechanical Features of the Liverpool Water-Works, and on the Supply of Power by Pressure from the Public Mains, and by other Means," by Joseph Parry, Water Engineer, Liverpool; and on "The Disposal and Utilization of Blast Furnace Slag," by William Hawdon, of Middlesborough.

The annual report of the Council showed that the Institution is yearly increasing in wealth and numbers, the accumulated property being now, in the 45th year of the society's existence, about $180,000. The excess of receipts over expenditure last year was about $10,500. The total membership is now 2,077. The presidency is held for a period of two years. Mr. Joseph Tomlinson, an old railway engineer, who dates back to the Stockton & Darlington days, was succeeded by Mr. William Anderson, LL.D., F. R. S., the Director General of Ordnance Factories, one of the best known and most respected mechanical engineers in England.

The appointment of a civilian to his important post was extremely popular with all classes, except the military, who look on such berths as a perquisite to the army, ignoring the fact that the training of a soldier is not calculated to fit a man to take charge of a large and complicated manufacturing establishment. The report of the Council gave particulars of progress made by the research committees, which are so prominent a feature in the work of this Institution, and upon which a part of the income of the Institution is spent every year. The Marine Engine Trials Committee has just brought its labors to a close for the present, having made trials with about half a dozen steamers of various types. There is, however, one more report to be presented. The Steam Jacket Committee has not yet made public the results of its experiments. These are looked forward to with considerable interest. It would have been better had the steam jacket investigation been gone on with first, so as to have been available for the marine engines trials. The Committee on Friction has set to work again with renewed energy, now that its chairman, Mr. Tomlinson, is released from the duties of the presidential chair. The Alloys Committee is also to give another report shortly.

Mr. Parry's paper was a useful contribution, containing the results of actual working with power taken from various sources. The Liverpool water-works are the property of the corporation, and it was contemplated some time ago by the authorities to establish a system of power distribution by means of the water supply, using the ordinary pressure in the mains of about 60 to 70 lbs. per sq. in. In order to get a basis of comparison, Mr. Parry instituted inquiries with a view to finding out what were the usual working conditions under which power was used in situations where the proposed hydraulic supply would be likely to be introduced. The paper under notice was the outcome of these inquiries. The Liverpool water supply is of more than ordinary interest at present, from the approaching completion of the new Vyrnwy works. Originally Liverpool obtained water by pumping, and there are yet at work some good examples of old-time pumping engines, among them a Cornish engine and boilers erected in 1840, a crank engine erected in 1837, and another Cornish engine erected in 1846. The latter was made by the old established firm of Harvey & Co., of Hayle, in Cornwall. It seems a strange thing now to bring engines from Cornwall to Lancashire, but Cornwall was the original home of big engines, and there James Watt found the chief field for his labors and worries, at a time not so far distant when reckoned by years, although centuries back if measured by events.

The Hayle engine here mentioned has a 50-in. cylinder and 9-ft. stroke. The pump is 17¼ in. in diameter, by 8-ft. 9 ins. stroke. The steam pressure is 35 lbs. and the cylinder is jacketed. Such was the ordinary pumping engine of 50 years ago, and a remarkably efficient instrument it was, having held its own in the matter of economy up to quite recent times. The duty of the engine in question, ascertained by a recent trial, was 55,700,000 ft.-lbs. per cwt. of coal, the horse power being 86.66. The average rate of water supply in Liverpool per unit of population per day is 24½ gallons. The weight of goods handled in Liverpool per annum averages 14,000,000 tons, and it was thought that the working of cranes for this purpose would afford one of the chief objects of the proposed hydraulic power distribution system. The great bulk of the loading and unloading in Liverpool is still done by steam power, but in many places gas engines have been fixed—there are about 650 now in use for handling freight—and they appear likely to spread still more rapidly. Some years ago a system of compressed air transmission was tried, but it proved a failure, as has the Birmingham compressed air scheme, of which such great things were promised a year or two ago, and upon which so much money has been thrown away. The Hydraulic Power Co. of Liverpool also supplies water for motor purposes at a pressure of 700 lbs. per sq. inch. Electric motors are not as yet used in Liverpool, a fact largely to be attributed to the comparatively moderate price of gas.

It is found that with an available pressure of 60 lbs. per sq. in. in the mains, properly utilized, and at the present rate of 14 cts. per M. gallons, the cost of lifting one ton weight to a height of 50 ft., is 2 cts. A great drawback to the use of water power arises from the difficulty of adjusting the work to the load; for it may take as much water to lift 1 cwt. through a given distance as it would to raise a ton; that is to say, if the lift is of one ton capacity it will take the full quantity of water, however small the load. Many devices have been introduced to overcome this difficulty, but none of them can be said to have actually solved the problem. An advantage that may arise with hydraulic power is the ability to use the educted water for other purposes. The Lancashire & Yorkshire Railway work passengers elevators and uses the exhaust water for filling the locomotive boilers.

A comparison is made between gas and steam hoisting. Three representative groups of steam hoists are taken. The average cost of working of the best group is 0.138 ct. per ft.-ton; as compared to this the charge against the gas engine is 0.108 ct. per ft.-ton. In the case of the steam hoists, coal, oil and stores, water, wages and repairs are included; and, in the case of the gas hoists, gas, oil and stores, wages and repairs are included. In another table the cost of gas is given and it ranges from 0.0112 ct. per ft. ton. to 0.058 ct. per ft. ton. Gas would average about 60 cts. per M. ft. in Liverpool. The cost of hoisting by hydraulic power as supplied by the Hydraulic Power Co.'s mains averaged from 0.07 to 0.09 ct. per ft.-ton. In the discussion which followed the reading of the paper nothing of particular interest was brought out, except that generally it was admitted that low pressure water (60 to 80 lbs. per sq. in.) from company's mains cannot compete with high pressure water (700 lbs.) when the rate for the latter does not exceed $1.20 per M. gallons.

Mr. Hawdon's paper on furnace slag disposal dealt with a subject of considerable importance, if not one of wide interest. The bait no doubt is alluring. Blast furnace slag looks as if something ought to be done with it. The blocks as they lie on the tip seem so hard and solid that one cannot see why they should not be molded into bricks, used for foundations of buildings, broken up into road metal, applied to the ballasting of roads, or used for any of the hundreds of purposes for which a good clean metal is required. The answer, of course, is that generally it costs more to conform to these requirements than the product is worth, although, as will be seen, a certain portion of slag is put to useful purposes. In the United States there is not so much trouble with slag as in England. It is less in quantity and can be disposed of by means which are not so readily available in this country.

The old way of dealing with slag, when operations were not on so big a scale as they have since grown, was to keep it in small parcels and carry it out to the "tip." Now we run it hot into slag wagons—which may be described as molds on wheels—holding as much as 4 tons of the material—and so carry it to the dump, which, in the case of large iron works, soon assumes the dimensions of a small mountain. As the land covered is sometimes worth as much as $5,000 per acre, it will be seen that rent alone represents a considerable standing charge, for the land once used as tip is worthless for other purposes. Where water carriage is available the "slag balls" are often carried out to sea by steam hoppers, but then the balls have to be broken up into pieces convenient for handling. There is, however, a limited demand for slag and to some of its uses the author referred. The most interesting is the manufacture of slag wool or silicate cotton, which is an article of commerce not illnamed, as it has the appearance of raw cotton. The writer is not aware

whether this material is well known in America or not. It is well known and largely used here as "mineral wool;" Eng. News, Dec. 26, 1891.—Ed.], but in any case a short description of its method of manufacture may prove interesting.

A jet of steam is made to strike the stream of molten slag. This breaks up the stream, and small particles of slag, about the size of large shot, are thrown to some distance. Each shot carries behind it a tail, which becomes more attenuated the further the shot travels. The shots, which constitute about 75% of the whole mass injected, by their superior gravity fall into a receptacle placed for them, while the filaments are drawn into a chamber by an induced current of air. "Slag shingle" is used for concrete making, and is made on a machine designed by Mr. C. Wood, of Middlesborough. This machine consists of a horizontal annular table about 16 ft. diam. It is formed of segments, or cooling plates, about 2 ft. wide, and having wrought iron pipes cast in them. Through these water flows. While the table is revolving slowly the molten slag is run upon it, and spreads out to a thickness of from ¾-in. to 1 in. When the slag has consolidated water is run upon it to cool it further, and then a set of scrapers push the slag off into iron wagons, into which it falls in small pieces. Slag sand is another by-product of the blast furnace. It is made by a machine consisting chiefly of a wheel, or short drum, of about 11 ft. diam., and revolving on a horizontal axis. The rim of this wheel is formed in the shape of an annular internal trough; that is to say, the vertical flange forming the side of the trough projects inwards toward the axle, so that the outer rim of the wheel is the cylindrical bottom of the trough. Water is run into this trough to the depth of 18 to 24 ins., and the wheel is kept revolving. The molten slag is run into the water, with the result that it forms into a spongy sort of sand. The trough is divided up into segments by means of radial partitions, which are perforated so that water will run through, and thus remain in the bottom of the annular trough, while the slag sand will be carried upward by the revolution of the wheel. When the sand gets toward the top of the wheel, as the latter revolves, it falls out by gravity into an inclined shoot which takes it into wagons. This sand has been extensively used for making concrete bricks, which have been used in London for house building, and have been sold at a profit at as low a price as $2.50 to $2.75 per M. In spite of these and some other important uses for furnace slag, the supply enormously exceeds the demand, and Mr. Hawdon has introduced a machine for the more effectual disposal of the material. It consists chiefly of an endless chain, composed of solid bar links. This chain is caused to travel on a couple of large pulleys, placed a convenient distance apart, and running on horizontal shafts which are situated in the same horizontal plane; that is to say, the chain travels horizontally (approximately) excepting when it is passing round the drums. Mounted on the chain is a continuous series of shallow pans or trays, and into these the stream of molten slag is directed. The pans have overhanging lips, so that the liquid slag does not find its way down to the chain as the succession of pans passes under the molten stream. After each pan has received its charge of slag it passes into a tank of water. This is effected by allowing the slag pans to dip down into the water trough, the natural sag of the chain being sufficient for the purpose. The material is further cooled by a spray directed on it from a perforated pipe and is then tilted into wagons as the chain passes over the further pulley. The flat cakes of slag, about 1 to 2 ins. thick, break up into pieces from the size of a nut to a few pounds in weight. It is largely used for road making, especially for the foundation of new road. Two men per shift do the whole of the work required for the disposal of 6,000 to 7,000 tons of slag per week. For tipping on the slag "mountain" three locomotives were required per shift, but with the machine one locomotive does the work of shifting the trucks with assistance from another locomotive for about one-quarter the time. The enormous wear and tear of bogies and boxes, due to hot slag, is done away with.

The summer meeting is to be held this year at Portsmouth, and should prove very successful, as the co-operation of the Lords of the Admiralty has been promised. The Royal Dockyard will form a most interesting feature, perhaps more from a historic than an engineering point of view.

LIVERPOOL ENGINEERING SOCIETY.—At the meeting on Feb. 10, Mr. Thomas Norris read a paper on "Engineers' Tests for Iron Considered, and Suggestions for Standard Uniform Tests." He showed by tables of numerous tests how engineers would ask for different tensile strains for the same class of work, adding that the iron produced in the localities named was uniform in quality. He paid a high tribute to the reduction of area test, as being one that gave more consolation to the engineer in case of work coming to grief than any other test specified. The elongation test, which he said was only another form of test for ductility, was not to be depended upon with the same ease and comfort as contraction of area, and the fact that the former test was specified by nearly all engineers was anything but creditable. He treated the limit of elasticity test with disfavor. His suggestions for standard uniform tests and conditions were put in the simplest form.

ILLINOIS MINING INSTITUTE.—This society has been organized at Springfield, Ill., for the purpose of promoting safety in mining operations and of discussing mining matters generally. Meetings will be held quarterly. The officers are as follows: President, J. C. Simpson, St. Louis; Vice-Presidents, Richard Ramsey, Braceville; Walter Rutledge, Alton; Hugh Murray, Sparta; Secretary, J. S. Lord, Springfield; Treasurer, Thomas R. Stockett, St. Louis; Executive Council, William Scaife, Coal City; G. C. Simpson, Springfield; J. D. Peters, Murphysboro; Robert Lee, Cable; R. D. Fletcher, Streator.

THE CIVIL ENGINEERS' CLUB OF CLEVELAND.—A regular meeting was held Feb. 9, with President Gobeille in the chair and 27 members and 3 visitors present. Mr. John L. Culley read a paper on "Mining Engineering." He gave an interesting account of the work to be done in making surveys of mines; from the time the engineer arrives on the ground till the last course is finished, and the manner in which this work should be done. The difficulties encountered and the methods of overcoming them were fully described, also the checks that are used in proving the correctness of the survey, and the methods of locating the required lines on the surface. The paper was discussed by a number of members, and several ingenious methods were described for overcoming many of the difficulties encountered during the execution of this kind of work.

NEW ENGLAND WATER-WORKS ASSOCIATION.—The quarterly meeting will be held at Young's Hotel, Boston, Mass., March 9. There will be a meeting of the executive committee at 12.30 and lunch will be served at 1 p. m. At 2 p. m. a series of brief papers will be presented by the following members: Solon M. Allis, Malden, Mass.; George C. Chase, Taunton, Mass.; Desmond Fitz Gerald, Brookline, Mass.; F. F. Forbes, Brookline, Mass.; F. L. Fuller, Boston, Mass.; S. P. Griffin, Lowell, Mass.; J. L. Harrington, Cambridge, Mass.; Willard Kent, Woonsocket, R. I.; A. F. Noyes, West Newton, Mass.; George A. Saunders, Hudson, N. H.; L. A. Taylor, Boston, Mass.

Each of these talks will occupy but a few minutes in delivery and will be descriptive of some personal experience or observation. As each topic will be selected by the writer thereof, quite a range of subjects will be presented. Discussion will follow upon the papers and such topics as may be introduced.

R. C. P. Coggeshall, Secy., New Bedford, Mass.

ENGINEERS' CLUB OF ST. LOUIS.—The regular meeting was held on Feb. 17, President Johnson in the chair and 50 members and 8 visitors present. Mr. Robert Moore spoke on the subject of "The Merchants' Elevated Terminal Railway," and exhibited a large number of views showing the work as it progressed from the foundations to the completion of the structure. A number of interesting tests in regard to fastening the anchor bolts for the columns were described, and it was shown that when the bolts were placed in rock, Portland cement was the most satisfactory.

Prof. J. B. Johnson then described "A Straight Line Railway Survey Between St. Louis and Chicago." The survey now being made for the Chicago & St. Louis Electrical Ry. Co. is proceeding in a straight line from East St. Louis to Chicago. A casual inspection of the region to be traversed indicated that a straight line road would probably fit the ground as well as any other and would not pass through any town or village of importance, which for a high speed road is very desirable. The question of grade also is unimportant in this case, since grades as high as 5 or 6% can readily be overcome by a single or double car electric service. Since the proposed speed is 100 miles per hour, it is a real advantage to avoid curves. If a straight line can as well be secured, therefore, as any other, it was thought best to do so. The direction of this line has been computed from the known latitude and longitude of the two terminal points, and the line is being run by a transit, the forward points being set by double reversals of the instrument and bisecting the space between the two positions. The azimuth of the line will be checked every ten miles by observations on Polaris, made at any convenient hour, using a table especially computed for such work. The railway and its location were described in Engineering News, Feb. 20.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.—At the regular meeting, at Pittsburg, Pa., Feb. 16, Mr. Wm. Metcalf read a paper on "Smoke." He said that when the question is attacked from a practical standpoint it is found that the difficulty of mixing the gases to produce perfect combustion is so great that it is practically impossible. The author explained the working of the blast furnace, and showed that the suppression of smoke by the admission of large quantities of air means also the burning up and waste of the iron by oxidation. With natural gas boilers may be fired smokelessly when gas is plenty, but it is not economical, and when they work best there is a little smoke. In other words, there must be some smoke from fuel when it is being used to the best advantage all around. Mr. Metcalf says that the best authorities he can find put the extreme loss from smoke at 5% and the mean loss at 2%. Smoke-consuming devices on the market claim a saving of 10 to 25%; but they are really heat savers where they are anything at all, and the user must look well to their real effect, for in preventing smoke they may also burn up ten times its value in iron and steel or valuable refractory material. The present "wastes of heat," amounting to about $1,000,000 annually in this country, may be fairly divided between wasted fuel and burned iron and steel. The author suggested that the problem for the future engineer was the direct conversion of the heat of fuel into electricity, and this could be reconverted into work without smoke. He claimed that smoke in itself was not unhealthy, and the smoke from bituminous coal was less objectionable than that from anthracite to weak pulmonary organs, for in the latter case there was no unctuous, protecting coating of soft, pure carbon to save them from torture and destruction.

Discussion followed from Mr. H. K. Parker and Mr. Koch on the comparative cleanness of the atmosphere of Birmingham, England. Mr. Koch said that the streets there may be clean and the smoke gone, but it is because the men who make the smoke are also gone. Since steel has taken the place of iron, puddling has ceased, and Birmingham now only manufactures fine grades of finished products. He indorsed Mr. Metcalf, stating that smoke might be lessened but could not be abolished. When working under Dr. Percy in London he had to appear before the Committee of the House of Commons as a witness, and it was proved before that Committee that every householder delivered four times as much smoke from each square foot of grate surface as any manufacturer. It was easy to reduce smoke from boilers in a mill, running constantly and evenly for ten hours, such as a cotton mill; but it was impossible to prevent smoke in an iron or steel mill where the boilers are subject to demands for large amounts of steam at one moment and then suddenly dormant. Dr. Sutton spoke confirming Mr. King's letter from Birmingham, as noticed by himself when living there. He made especial attack against the smoke issuing from all the small industries of Pittsburg, ending by saying: He thought the smoke issuing from a bakery baking doughnuts and destroying a ward was one thing and the smoke issuing from the lofty stacks of a steel works was another.

COMING TECHNICAL MEETINGS.

WESTERN SOCIETY OF ENGINEERS.
March 2. Secy., J. W. Weston, 280 La Salle St., Chicago.
ENGINEERS' CLUB OF ST. LOUIS.
March 2. Secy., Arthur Thacher, Odd Fellows' Building.
AMERICAN SOCIETY OF CIVIL ENGINEERS.
March 2. Secy., F. Collingwood, 127 East 23d St., New York.
ENGINEERS' CLUB OF MINNEAPOLIS.
March 3. Public Library Bldg. Secy., F. W. Cappelen.
ASSOCIATION OF CIVIL ENGINEERS OF DALLAS.
March 4. Secy., E. K. Smoot, 803 Commerce St.
TECHNICAL SOCIETY OF THE PACIFIC COAST.
March 4. Secy., O. von Geldern, 819 Market St., San Francisco.
ENGINEERS' CLUB OF PHILADELPHIA.
March 5. 1122 Girard St. Secy., J. C. Trautwine.
SWEDISH ENGINEERS' CLUB.
March 5. Secy., P. Valentine. At 281 Union St., Brooklyn, and 646 North 10th St., Philadelphia.
NORTHWEST RAILROAD CLUB.
March 5. Union Station, St. Paul.
CIVIL ENGINEERS' SOCIETY OF ST. PAUL.
March 7. Secy., C. L. Annan.
DENVER SOCIETY OF CIVIL ENGINEERS.
March 8. Secy., Geo. H. Angell, Jacobson Block.
ATLANTA SOCIETY OF CIVIL ENGINEERS.
March 8. Secy., Parker N. Black, Capitol Block.
CIVIL ENGINEERS' CLUB OF CLEVELAND.
March 8. Secy., A. H. Porter, 50 Euclid Ave.
NORTHWESTERN SOCIETY OF ENGINEERS.
March 8. Occidental Block, Seattle. Secy., E. H. Warner.
NEW ENGLAND WATER-WORKS ASSOCIATION.
March 9. Boston, Mass. Secy., R. C. P. Coggeshall, New Bedford, Mass.
NEW ENGLAND RAILROAD CLUB.
March 9. United States Hotel, Boston. Secy., F. M. Curtis.
ENGINEERING ASSOCIATION OF THE SOUTHWEST.
March 10. Secy., O. H. Landreth, Nashville, Tenn.
ENGINEERS' AND ARCHITECTS' CLUB OF LOUISVILLE.
March 10. Secy., Edward Mead, Norton Building.
NORTHWESTERN TRACK AND BRIDGE ASSOCIATION.
March 11. Union Station, St. Paul.
TECHNICAL SOCIETY OF NEW YORK.
March 12. 194 Third Ave. Sec., H. Schreiter.
ASSOCIATION OF ENGINEERS OF VIRGINIA.
March 12. At Roanoke. Secy., J. E. Schick, Roanoke, Va.
ENGINEERS' CLUB OF KANSAS CITY.
March 14. Baird Building. Secy., H. Goldmark.
WISCONSIN POLYTECHNIC CO.
March 14. Secy., E. F. Neukom, Milwaukee, Wis.
WESTERN RAILWAY CLUB.
March 15. Rookery Building, Chicago. Secy., W. H. Marshall
ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.
March 15. Secy., J. H. Harlow, Pittsburg, Pa.
BOSTON SOCIETY OF CIVIL ENGINEERS.
March 16. Secy., S. E. Tinkham, City Hall.
CANADIAN SOCIETY OF CIVIL ENGINEERS.
March 17. Secy., C. H. McLeod, Montreal, P. Q.
ENGINEERS' CLUB OF CINCINNATI.
March 17. Secy., J. F. Wilson.
SCANDINAVIAN ENGINEERING SOCIETY OF CHICAGO.
March 17. Secy., T. G. Philfeldt, 113 Adams St.
SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.
March 17. At Atlanta, Ga. Secy., F. A. Charlot, Macon, Ga.
NEW YORK RAILROAD CLUB.
March 17. Secy., H. G. Prout, 75 Broadway.
MONTANA SOCIETY OF CIVIL ENGINEERS.
March 19. Secy., F. D. Jones, Helena.
CENTRAL RAILWAY CLUB OF BUFFALO.
March 24. Secy., Jas. Macbeth.
AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
May 16 to 20. San Francisco, Cal. Secy., F. R. Hutton, 12 W. 31st St., New York.

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AND
AMERICAN RAILWAY JOURNAL.

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CHAS. W. BAKER, E. E. R. TRATMAN, M. N. BAKER, F. P. BURT, } ASSOCIATE EDITORS
GEO. H. FROST.....BUSINESS MANAGER

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ADVERTISING RATES, 20 cents per line agate measure. Schedule sent on request. Changes of advertisements must be in hand on Tuesday afternoon; new advertisements, Wednesday afternoon; transient advertisements, not later than Thursday noon. The last pages go to press early on Friday, and we shall be obliged if subscribers who fail to receive their papers promptly will notify us without delay.

Owing to the pressure on our space for this issue we are obliged to hold over until next week our third and concluding article on "Railway Accidents to Persons."

A valued and well-informed correspondent writes us in regard to the editorial note in our issue of Feb. 13 relative to steel beams:

You say, "Their natural price at the present time, when the demand has become prodigious, is not greatly different from that of rails." This is very far from correct. Steel rails are made in the best equipped mills at the rate of 1,000 tons per day, whereas the maximum output of steel beams in any of the mills making them has so far not reached an average of 150 tons per day. With this vast difference in rate of production not to speak of anything else, you will see that the cost of rails and beams must be very widely apart.

Let us see how this may be, by comparison with foreign prices. Of course, if foreigners can sell I-beams at about the price of steel rails, there is no reason why Americans should not do likewise. Belgium is the great I-beam country of Europe. In Britain they are hardly quoted separately, partly, as we infer, because their price differs so little from other forms of rolled iron and steel, partly because I-beams (or "joists," as the English call them,) are very largely imported from Belgium. The latest Belgian quotations which we find in our exchanges, as also the latest German, French, British and American, stand as follows:

		Belgian.	French. (20 cts. per franc).
Steel rails, heavy sections		$22	$32
"Joists" or I-beams	for exp't,	23	.....
	home use,	24	.....
Angles	ord'y	25	28 @ 29
	ship	26	
Bars	for exp't,	23	iron, 30 @ 38
	home use,	24	steel, 38

	German. 25 cts. per mark.	English. $5 per £	American.
Steel rails, heavy sections	$28.75 @ $30	$20.60 @ $20.62	$30.00
"Joists" or I beams	steel 35.00	.....	53.76
	iron, 32.50	.....	@62.70
Angles	iron, 27.50 @ 35.00	iron, 26.25 27.50	42.56 @ 47.00
Bars	iron, 32.50 @ 33.75	27.50	.....
	steel, 33.00 @ 36.00	@35.00	.....

It is apparent from the most casual study of this table that the prices of I-beams abroad are but little more than steel rails and about the same as (or a little lower than) angles and bars, whereas in America all of these are very much dearer than steel rails, and I-beams (even since the recent break in price) very much dearer yet than angles and bars.

The Lehigh Valley brake tests, which are described elsewhere in this issue, have confirmed the suspicions created by the late Burlington tests [Eng. News, Feb. 13, 1892] that the new triple valve of the New York Air Brake Co., in its present condition, is likely to give serious trouble in the ordinary conditions of service by failure to release. It is fair to say that the New York Co. claims this trouble to be due to imperfections in manufacture, caused by the haste with which the valves were made in order to have them ready for the tests. Whether the makers can overcome this trouble by more accurate manufacture, or by changes in design, remains to be seen; but at any rate they intend to try, and, if successful, further public tests may be expected.

It need hardly be said that while an uncertain release is not the most dangerous fault which a brake can have, it is a fault which has always been an annoying one even with the best brakes, and which will surely and properly condemn any brake which falls far behind in this respect. The best brake expert cannot say with certainty whether this vital defect can be overcome in the present form of the New York triple valve; and another knotty question is whether the New York Company can successfully defend itself against the Westinghouse Company's suit for infringement of patents. Service tests must settle the one, and the U. S. Circuit Court is to consider the other in April. There is no manner of doubt that the quick-action brake was, to an exceptional degree, the sole invention of Mr. Geo. Westinghouse; was a decided departure from the forms previously in use, and was invented only within the last four years, or since the Burlington tests of 1886-87 showed some new departure to be necessary. It would appear natural to expect that Mr. Westinghouse's long experience in patents would lead him, under these circumstances, to fully protect himself; but the uncertainties of patent litigation are such that the protection which he deserves in equity he may not receive.

The account which we give elsewhere of the results thus far obtained in the development of the steam turbine certainly contains much to warrant the belief that in many situations that exceedingly interesting and little known type of motor may yet displace the steam engine. A successful rotary steam engine has been the dream of thousands of inventors; but while the motor which we elsewhere describe and illustrate does all and more than the most sanguine worker on rotary engines has considered possible, it is radically different in its mode of operation from the class of devices generally known as rotary engines. The steam turbine, in fact, is exactly what its name implies; and it utilizes the reaction due to the weight of the steam currents passing through it as truly as any turbine water-wheel utilizes the reaction from the flowing water.

The most astonishing fact is that the steam turbine seems to have been so perfected already as to use steam with an efficiency equal to that of a first-class compound engine. If such records can be obtained at so early a stage in the development of the motor, it seems safe to predict that the future will show a great improvement even over this.

Besides this, it is plain that the steam turbine promises to facilitate progress in many directions where the weight and cost of the ordinary steam engine have hitherto been barriers. One style of motor illustrated, which weighs complete but 105 lbs., has developed over 25 HP., or 1 HP. for about 4 lbs. of weight. This can certainly be largely reduced by using steam of higher pressure. The best record in this line with steam engines of ordinary type which we now recall has been made by Mr. H. S. Maxim. In working to develop a motor light enough for aerial navigation he has made a 100 HP. engine weighing 600 lbs.

We regret to say that in the development of the steam turbine England seems to be in advance of this country. Still the turbine which has been developed here by one ingenious inventor, seems in some respects to promise better than the turbine which has come into considerable use in England; and it is to be hoped that it may soon be made commercially available.

THE CHICAGO WATER SUPPLY AND TYPHOID FEVER.

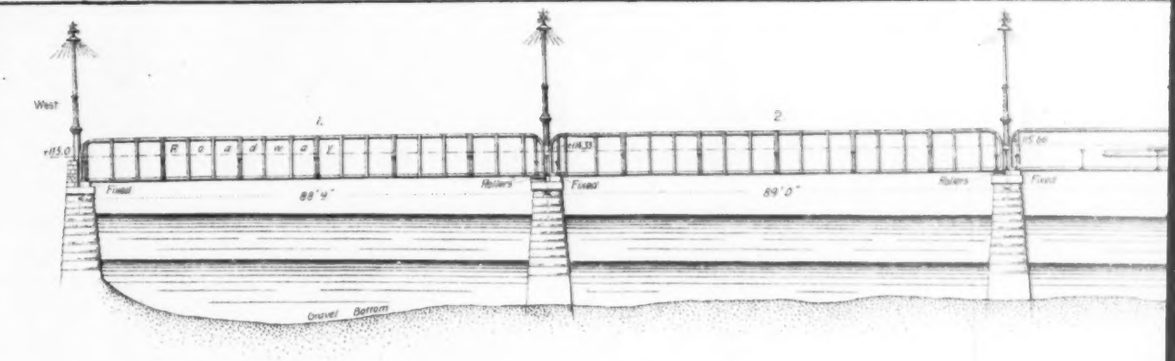
The Chicago people are very much exercised just at present, and with very good reason, over the quality of their water supply. The cause for their anxiety is the following official record of the deaths from typhoid fever in 1890, 1891 and January, 1892.

	1890.	1891.	1892.
January	53	67	311
February	136	61	...
March	103	71	...
April	45	136	...
May	82	408	...
June	107	167	...
July	86	200	...
August	115	182	...
September	95	198	...
October	72	171	...
November	67	150	...
December	47	186	...
Total	1,008	1,907	311

In New York City the average for the four years 1888-91 (which differed little from each other) was only 374 per year. Chicago, with not more than 60% of New York's population, had much over twice as many cases of typhoid fever in 1890, and doubled even this painful record in 1891. It is now having nearly as many deaths from typhoid fever in a month as New York has in a year, and New York has more in proportion than London, as the latter city (with 4,211,000 population against about 1,700,000 in New York and 1,100,000 in Chicago) only had 619 deaths from typhoid fever in 1890. Philadelphia, in 1876, had a typhoid fever epidemic, and for many years had a good deal of typhoid fever, presumably because of polluted water supply. Its death rate from typhoid in 1876 was only 9.36 per 10,000 inhabitants; Chicago's last year was 16.64. What it will be this year, who can guess? Recent chemical analyses of the city water have shown it to be much polluted by sewage, and a sufficient explanation of the marked tendency to typhoid fever. It appears also from some statements by Trustee Cooley at a meeting of the Drainage Board last week, that the drainage of not less than 180,000 people, for the most part living in the rapidly growing sections of the city, is even now being discharged into the lake direct, in addition to the quantity discharged into the Chicago River. That remarkable stream runs up hill, or inland, under ordinary conditions, as is well known, but it is also well known that from time to time, when floods or adverse winds occur, the Chicago River discharges a large part of its odorous fluids into the lake. Moreover, Trustee Cooley made the remarkable declaration "nem. con." that "it was not to be expected that present sewers emptying into the lake could be removed or closed."

The problem as it has thus developed is undoubtedly a serious one, and it is made more serious just at this time by the fact that an immense quantity of sewage and foul water from the Exposition will be added shortly to that which is now discharged directly into the lake. Stripped of all circumlocutions the problem is, how to pump from a still lake water which (in good part) returns a few hours later as sewage, without contaminating the lake which is both the alpha and the omega of this circulatory process. The only possible way to solve this problem is to create a current in or away from this still body of water which shall carry the sewage discharge away from the water intake. It is obvious that with a great and growing city like Chicago the current must be one of great volume, and such a one, large enough to serve also as a ship canal, has been for some years on the tapis. But whether such a scheme, on whatever scale, is not foredoomed to failure, and whether the true and only permanent remedy is not to completely separate the sewage discharge from the water supply, and take care of it independently, is a question which we do not think has yet had that impartial study which the situation demands. At least, no records of such study have as yet come to our knowledge, while a good many ex parte statements, plainly based on careful study of only one scheme, have reached us. Modern engineering resources have increased greatly within the past decade, and if a much less sum than will be required for the great canal scheme will not provide for permanently and certainly excluding all unpurified sewage from the waters of Lake Michigan, we shall be greatly surprised.

The present drift of opinion in Chicago seems to be distinctly away from the ship canal scheme, which is likely to cost some $20,000,000, and as to the details of which it seems impossible to secure agreement among the powers that be. A bill to repeal the law authorizing its construction is being officially urged; but the substitute therefor which seems now to command most favor is merely to push the intake further out into the lake, *i.e.*, four miles out instead of two miles, and eight miles out instead of



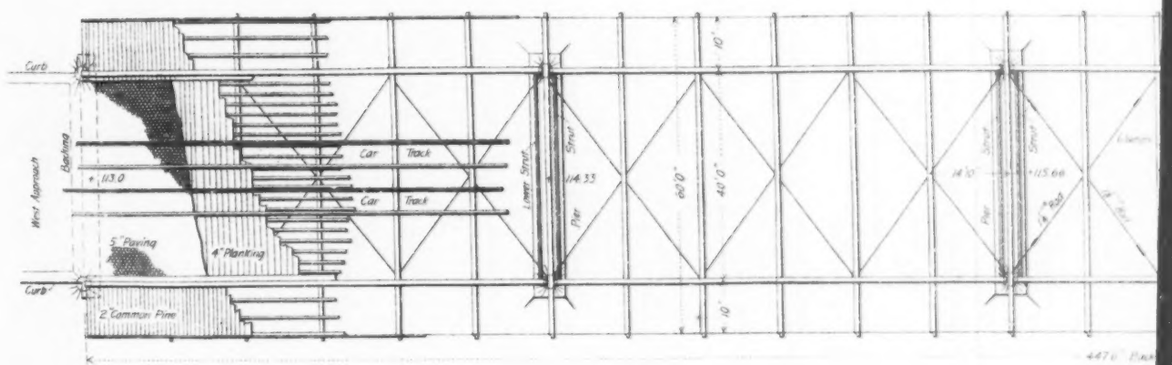


Fig. 1. G

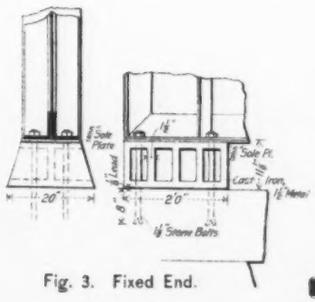
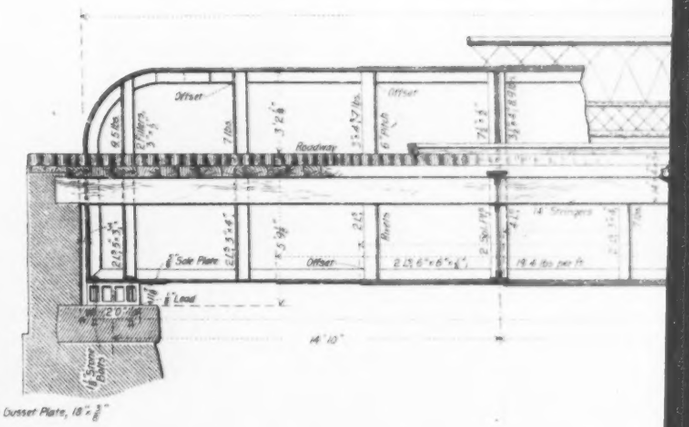


Fig. 3. Fixed End.



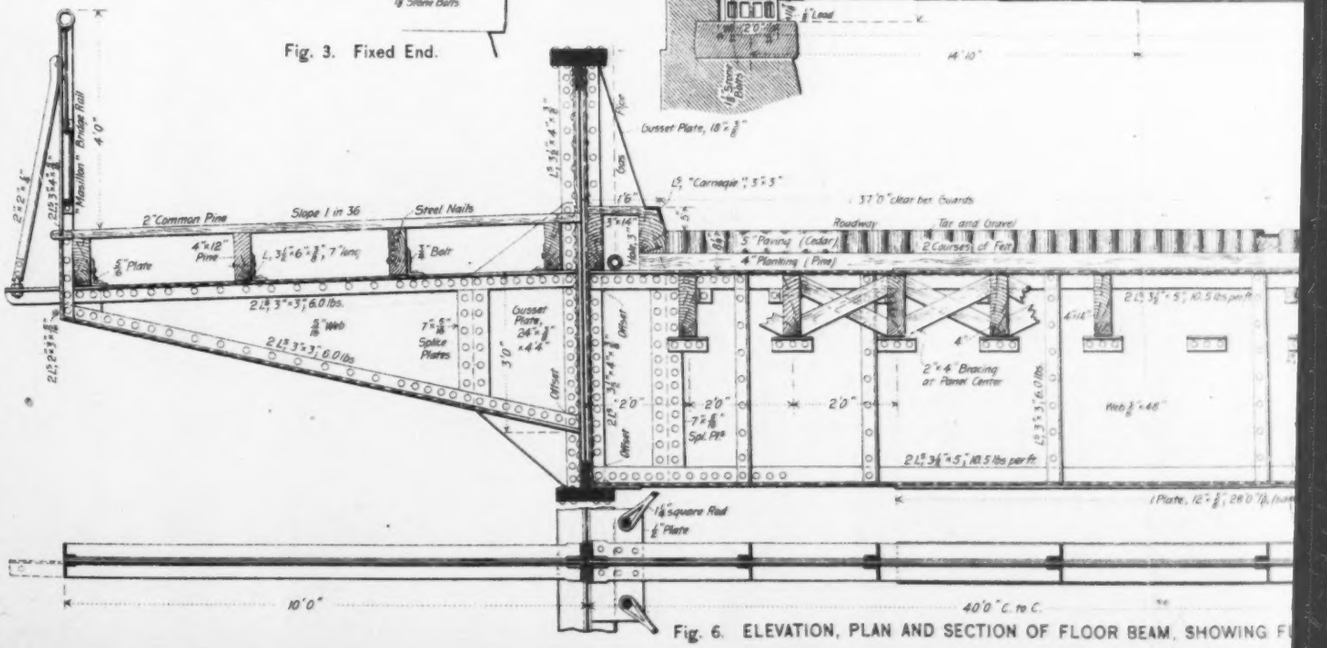


Fig. 6. ELEVATION, PLAN AND SECTION OF FLOOR BEAM, SHOWING FL

PLATE GIRDER HIGHWAY BRIDGE O

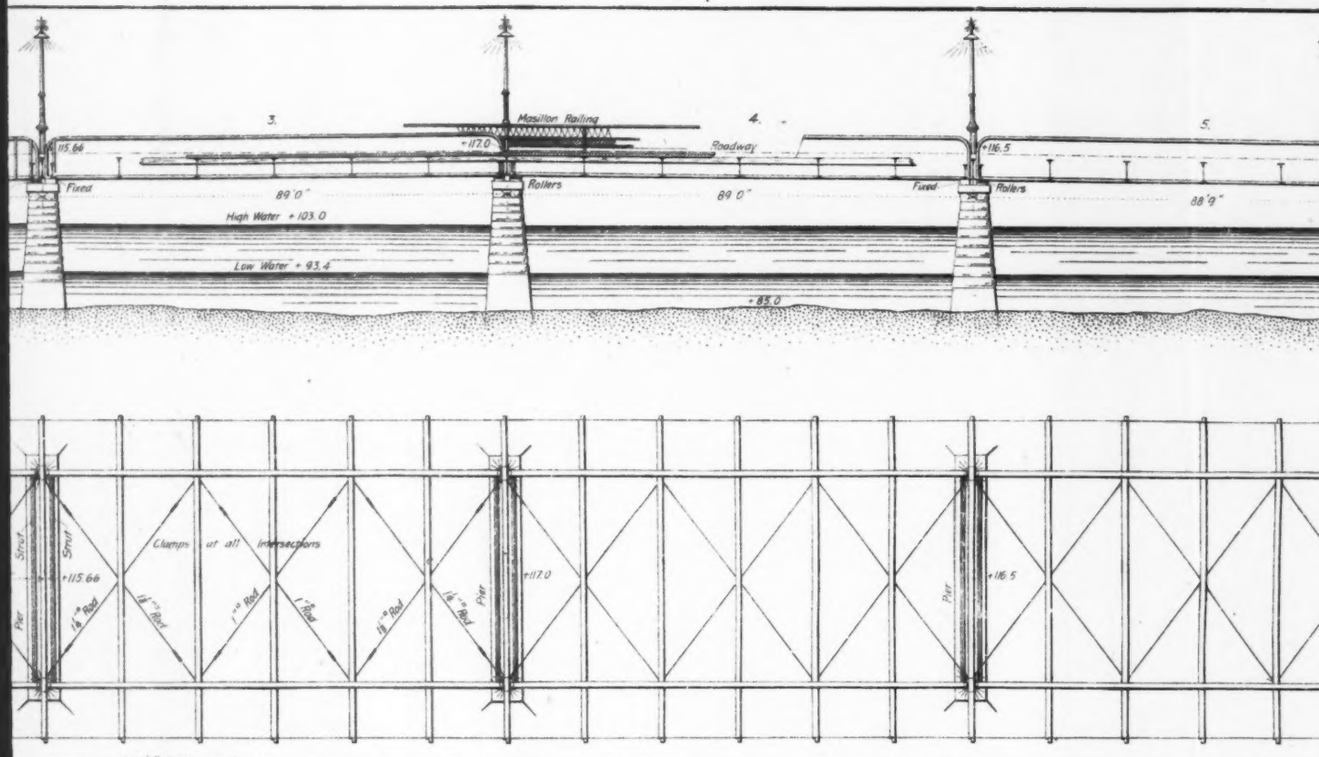


Fig. 1. GENERAL ELEVATION AND PLAN.

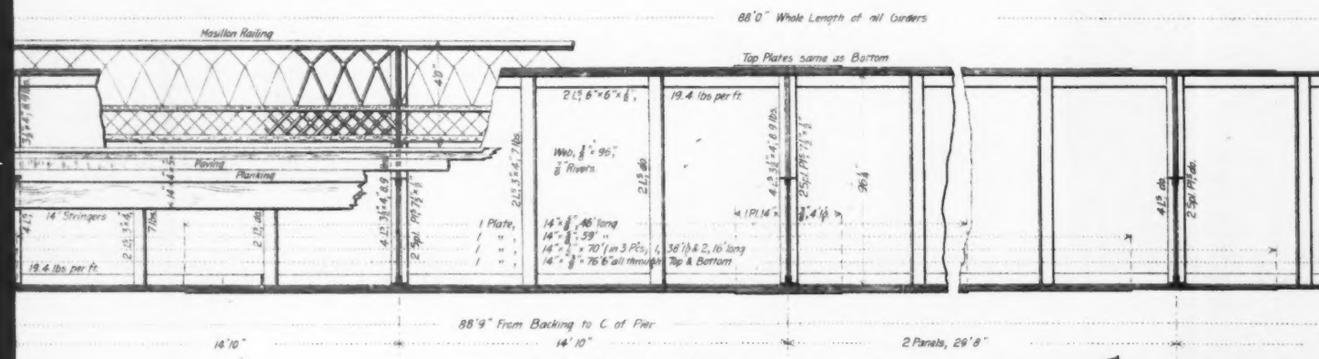
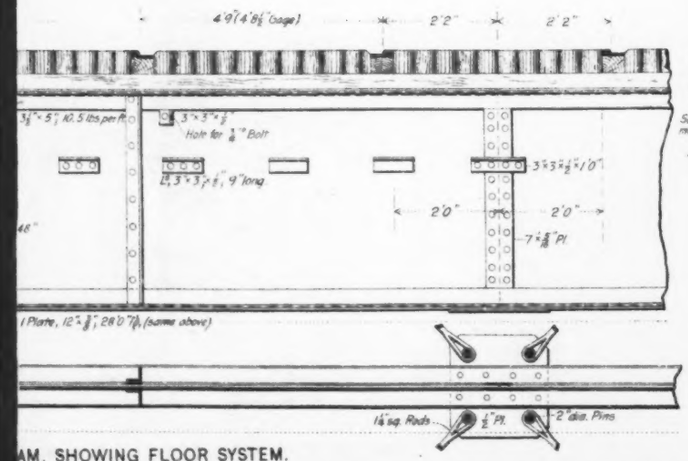

88'0" Whole Length of all Girders
Masilon Railing
Top Plates same as Bottom
40"
Paving
Planking
14" Stringers
19.4 lbs per ft.
19.4 lbs per ft.
Web, ⅜" × 96", ⅞" Rivets.
1 Plate, 14" × ⅜", 46' long
14" × ⅜", 59' "
14" × ⅜" × 70' (in 3 Pcs), 36' lb & 2, 16' long
14" × ⅜" × 76'6" all through Top & Bottom
88'9" From Backing to C. of Pier
14'10"
14'10"
2 Panels, 29'8"

Fig. 2. ELEVATION OF GIRDER.



AM, SHOWING FLOOR SYSTEM.

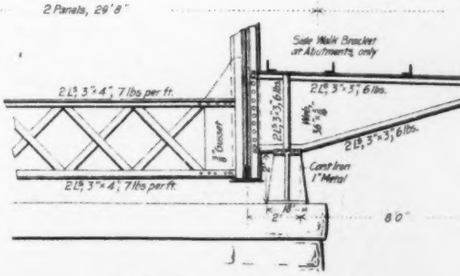


Fig.5. Strut at End of all Girders.

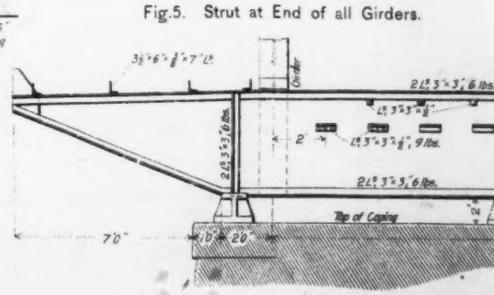
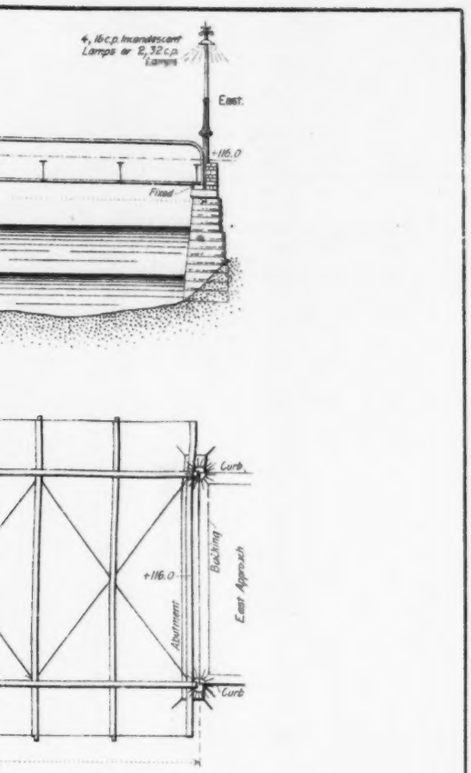


Fig. 7. ELEVATION OF FL

BRIDGE ON STATE ST., ROCKFORD, ILL. D. C. Dunlap, City Engineer.



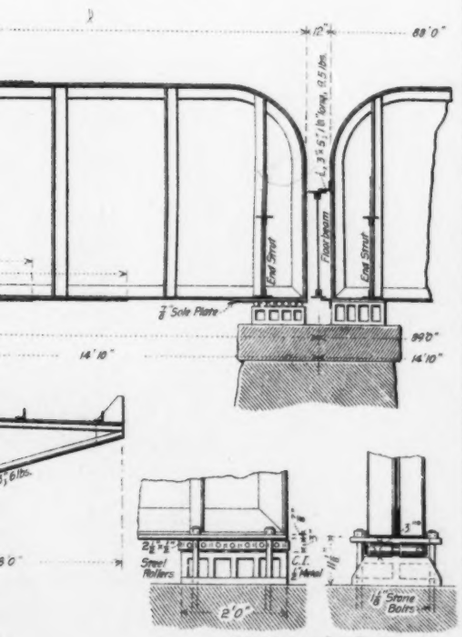
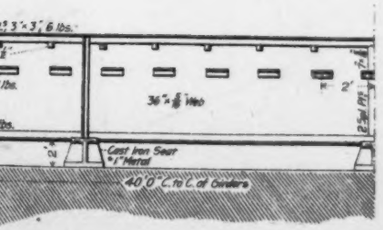


Fig. 4. Roller End.



N OF FLOOR BEAMS ON PIERS.

CHAS. HART & SONS, LITH., 26 VESEY ST., N. Y.

four.* But this is merely trifling with a serious trouble. It may be advisable as a temporary expedient, but it is obvious that even now, if the water two and four miles out is unfit for use, for some distance farther out it is not likely to be perfectly pure, and when Chicago has double its present population (which itmay have long before 1900) will be more contaminated than is the present supply, because a much larger percentage of the sewage than now will then be discharged directly into the lake.

The only permanent remedy, and one which Chicago ought no longer to neglect, would seem to be the permanent and complete separation of the water supply and the sewage discharge. As the lake must be relied on for water, it should not be relied on at all as a receptacle for sewage, but the latter should be collected in intercepting sewers and disposed of by pumping and purifying processes, if not carried off by an adequate and very large inland current. Precisely how this should be done, or what it will cost, we are not prepared to say, nor is it our province to do so, but we can say this, that many of the statements put forth as to what intercepting works would cost seem to be much exaggerated.

Moreover, it is to be always remembered that typhoid fever germs, unlike inert sewage matter, do not become innocuous by dilution, or (within reason) by heat or cold, or lapse of time.

THE REGULATION OF PRIVATE WATER RATES.

Three important cities in the United States supplied by private water companies are just now discussing municipal regulation of water rates. The cities are Indianapolis, Des Moines and Newport, R. I. Indianapolis and Des Moines seem to have the right to exercise such regulation already, but desire to place it in a clearer and firmer position. At Newport no semblance of power to regulate the water company's rates seems to exist, and authority to this end is being sought from the legislature. The general practice in this particular in several cities of the United States was set forth in our issue of Jan. 9, 1892, in connection with other particulars regarding franchises of water companies.

At Indianapolis the occasion of making a new contract between the city and water company has been very properly taken advantage of by the city, which now seeks, or at least some of the officials seek, to include in the new contract a specific provision for control of the company's rates by the city. The franchise granted by the city to the company in 1870 provides for charges to private consumers no higher than the average charges in cities of like population and having as efficient works. In case of disagreement between company and city the matter of rates is to be settle d by arbitration.

A franchise with such a provision as the above would doubtless prove to be better for the city concerned than a franchise with no provision regarding rates, for there really is something for the city to hold the company to, and in some cases the restriction of a company's rates to a point no higher than the average of other cities might really prevent excessive charges. But on the whole the provision cited seems objectionable. It is indefinite; it is possibly unfair to both company and city (which unfairness, however, is not likely to hurt any company); and it ignores the cost of the service rendered and proposes to base rentals upon efficiency of the works instead of cost of construction and maintenance.

The indefiniteness of the franchise will be best understood after quoting its exact words regarding rates, which were given in substance above. The franchise was granted Jan. 3, 1870, and provides that the charges for water in Indianapolis shall be no higher than "the average price paid by other cities of the United States and citizens thereof, of like population, that are supplied with as efficient works." What is meant by "like population" and "as efficient works"? These terms are each generalities, points for disagreement between city and company, fit subjects for the arbitrators provided for in the contract, and would be almost sure to call for their services if a council ever undertook to regulate rates on such authority. Further than this such a provision in a franchise may easily fulfil no other service than to lead to complacent feelings on the part of the city councilmen and those few citizens who give city affairs of this sort a passing thought. With such a provision in its franchise many a company might establish such a schedule of rates as it sees fit and no one ever take the pains to see whether they are the "average" rates or prices called for. In fact the rates at Des Moines, the City Solicitor believes, have never beenchanged since 1871, although, as noted below, the franchise provides that they are to be no higher than the average rates in other cities with efficient service.

If an attempt be made to secure for the citizens rates in accordance with the terms of the franchise, the question comes up, "What cities have a like population?" According to the last census Indianapolis had a population of 105,436. The next five cities larger and the next five smaller than Indianapolis are as follows:

Denver	106,713	Allegheny	105,287
Providence	132,146	Albany	94,923
Kansas City	132,716	Columbus	88,150
St. Paul	133,156	Syracuse	88,143
Rochester	133,896	New Haven	86,045

Of these ten cities all the larger ones, except Denver, are more than 25% greater than Indianapolis, and Denver and Allegheny are the only two that come within 10,000 of its size, Columbus being some 16% greater. Just how many cities might be included by anyone as of "like population" to Indianapolis would depend upon what could be best proven by a wider or narrower interpretation of the term.

If Albany were excluded it would then be possible to include only Denver and Allegheny, since none of the remaining cities named are so near the size of Indianapolis as Albany. Now in 1888 the Indianapolis Water Co. would have very likely wished Albany excluded, as its rates were very low. Of course the city would have wished it included for the same reason. But in 1890 just the reverse would have been true, since in 1889 the Albany rates were doubled to meet the added expense of new works, the city being obliged to meet this expense, or stipulated parts of the interest charges and sinking fund from water rentals.

At Indianapolis all the water is pumped, but it is pumped directly to the mains. Now, at Albany and at Denver a good part of the supply is by gravity, while at Allegheny all the water is pumped to a reservoir 217 ft. above the pumps. The franchise does not take into account such points as these. It does not recognize that direct pumping is cheaper than pumping to a reservoir, and that therefore cost of service is lower and rates should correspond. On the other hand, a gravity supply may be cheaper, although not necessarily so when first cost and interest charges are considered. Further than all this, there are just now two companies at Denver in bitter competition. This competition, with possible low rates, may continue for some time. Now, had there been a readjustment of rates in Indianapolis prior to 1889, and had the company succeeded in crowding out Albany against the city's wish as not being of "like population," the Indianapolis rates would then have been adjusted by those at Allegheny and Denver. In the following year the raise in Albany rates would have made the company desire to include them in the figures for averages, while the competition which began at Denver in 1890 and waxed warm in 1891, provided it resulted in lower rates, would certainly have been a reason for the city's demanding a readjustment.

The absurdity of regulating the rates of one city by an average of those of others might be shown in yet other ways, but it will be apparent to all without further discussion, as will the indefiniteness and unfairness of such a plan.

Cost of service is the only sensible basis for a regulation of rates. This being so, the city should have the power to revise rates at fixed periods. That the city may act intelligently and with fairness, the company's financial transactions should be fully reported to the city each year.

As has been stated the franchise of the Indianapolis Water Co. was granted to it by the city in 1870. While the privilege for average rates, commented upon above at length, was inserted in the franchise, the company organized under a law of 1865, that provided for the regulation of company's rates by the cities in which they are located. Whether or not this law is still in force and whether it was possible for the city to yield a privilege of this character, bestowed by the legislature (which is not probable), the city will do well in making a new contract to insert an unequivocal and unavoidable clause providing for municipal regulation of the rates.

Having spent so much time over the Indianapolis franchise but little will be required in connection with the similar, but more indefinite, clause in the franchise of the Des Moines Water-Works Co., especially as City Solicitor Hugh Brennan and his assistant, Mr. W. H. Bailey, have expressed themselves as strongly of the opinion that the city may regulate the rates under the provisions of a general statute of 1888.

The franchise of the Des Moines Water Co., granted by the city May 1, 1871, provides that the maximum rate shall be "no more than the average price paid in other cities of the United States having efficient water-works." Such a provision is practically of little or no use, as the city might about as well go to the courts asking an order for reduction of rates on the ground of exorbitant charges, as may be done in Massachusetts, as to attempt to secure satisfactory rates on such a basis.

The question at Des Moines seems to have been whether the general statute of 1888 providing that cities of the first class may regulate water, gas and electric lighting rates and meter rentals was applicable to Des Moines, which had granted a franchise in 1871 without provision for such regulation. The city solicitor seems to settle this point by stating that the Des Moines Water-Works Co. has amended its charter since 1873, when a statute was passed providing that all companies organizing or amending their organization under the statute should be subject to legislative control.

These discussions at Indianapolis and Des Moines have a direct bearing upon the situation at Newport, R. I., where the Newport Water-Works Co. has a 50-years franchise, granted in 1876, which neither provides for municipal regulation of rates or purchase of the works by the city.

Further light is incidentally thrown upon the situation at Newport, which will be more fully stated presently, by the following quotation from the report of City Solicitors Brennan and Bailey mentioned above:

> It has been held by the Supreme Court of the United States and the Supreme Courts of the States of Iowa, Illinois, Wisconsin, Minnesota and other States, that where property or employment is affected with a public use, the business in which it is used is subject to legislative control in all respects necessary to protect the public against danger, injustice and oppression, and that the state may regulate the charges of a corporation or person rendering a public service, the rates, however, to be such that the service is not performed without reward or just compensation.

The Mayor and City Council of Newport are now trying to secure from the Rhode Island Legislature power to regulate the rates of the Newport Water-Works Co. and also power to buy the company's works if the city should so desire. The movement was started a year or so ago by the present Mayor, Mr. Samuel R. Honey, a lawyer, who began writing a series of letters to one of the Newport papers calling attention to the high rates charged by the company and to some other matters affecting the city's interest. Before the series of letters was finished, in fact, when it was only well begun, the newspaper refused to publish any more letters as communications and Mr. Honey was obliged to insert them in the advertising columns. The question went into the local election, and Mr. Honey, as mayor, and a water-works reform city council were elected to the office last fall.

The people of Newport will do well if they profit by their own experience with excessive rates and, appreciating the inefficiency of such provisions for regulation as have been quoted above, aim to secure authority to fix the rates charged them for water.

The legislature of Rhode Island would do well to grant Newport the authority asked, both to regulate the rates and purchase the works. In addition, it might extend this authority to apply to other places supplied with water or light by companies and to provide that such companies should render to the municipalities granting them franchises a full yearly report as to their financial and other trans-

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* At the present time Chicago has the following intake tunnels:

Old 5 × 5 ft. tunnel	intake	2	miles out.
Second 7 ft. diam. tunnel	"	2	" "
New 8 ft. diam. tunnel (not yet in use).	"	4	" "
Hyde Park, 6 ft. diam. tunnel,	"	1¼	" "
Lake View, 9 ft. diam. tunnel (not yet in use)	"	2	" "

actions. This may seem too much, the last, especially, but the interests of good local government and fair dealing all around, demand it.

LETTERS TO THE EDITOR.

RAIL JOINT TESTS ON THE CHICAGO & NORTH WESTERN RY.

SIR: I inclose a statement of conditions of the Truss rail joint (together with others for comparison) after two years and four months test, under vraious conditions of track. The statement is compiled from the report of an inspection by an engineer of the Chicago & Northwestern Ry. to the engineering department of that road.

Your special attention is called to the comparison in percentage of joints in surface between our device and the 44 in. 6-bolt angle bar, where the conditions were all the same. The Truss joint showed 90.5% in surface and the other joint only 68%. The 24-in. channel base plate and 24-in. angle bar made a still poorer showing.

Rail Joint Tests on the Chicago & Northwestern Ry.

Kind of Joint.	Grade. Per cent.	Alignment.	Ties	Wt. of Rail. lbs.	No. of trains daily. Freight.	Pass.	When placed in track.	No. of jts.	Conditions. In surface. No.	Per ct.	Low. No.	Per ct.
Truss	0.3 0.6	Tangent	Ave.	72	10	6	May, 1889	542	455	84.0	87	16.0
Truss	1.0	1° 20′ 1° 30′ curve	Ave.	72	14	8	May, 1889	488	415	85.0	73	15.0
Truss	1.0	2° curve	Ave.	72	12	8	May, 1889	770	768	99.74	2	0.26
Truss	Condi-	Slight curve	Ave.	85	Same	Serv-	July, 1889	200	181	90.5	19	9.5
44-in. angle bar, 6 bolts	t'ns the	Slight curve	Ave.	85	Same	Serv-	May, 1889	200	136	68.0	64	32.0
32 in. angle bar, 5 bolts	same.	Slight curve	Ave.	85	train.	ice.	May, 1889	200	96	48.0	104	52.0
24 in. angle bar, 24 in. channel base plate	0.3 0.6	Tangent	Good	72	10	6	Dec., 1890	542	276	51.0	266	49.0
24-in. angle bar, 24-in. channel base plate	0 6	Tangent	Good	72	11	8	Oct., 1889	200	124	62.0	76	38.0
24-in. angle bar, 24 in. channel base plate	1.5	2° 2°30′ 3″ curve	Good	72	14	8	Dec., 1889	375	33	9.0	342	91.0
34-in. angle bar, 6 bolts	1.0	Tangent	Good	72	14	8	Jan., 1887	100	3	3.0	97	97.0

The result shows the excellence of our device, also substantiates our theoretical claims as to the action of the truss rods. We have demonstrated beyond any question that the deflection caused by the passing load over the joint is taken up by the truss rods, and that the wave of deflection passes unbroken from one rail to the other, through the joint. We can satisfy the most skeptical on this point by actual demonstration.

We have evidence from other roads using our device, which is equally satisfactory, all proving that it will maintain a track in better line and surface with less care, and consequently less cost for maintenance, than any other. Still engineers are fondling the long, heavy angle bars and claiming they are getting more strength by increasing their length, apparently forgetting that the ultimate strength in the bar is the units of strength between the ends of the rails, whether it is longer or shorter. If a 44-in. bar is stronger than a 24 in., is not an 88-in. bar stronger than a 44 in.? Why not increase the length to the full length of the rail?

Another absurdity—as it seems to us—is increasing the weight of the rail to gain additional weight for the angle bar by deepening the web of the rail. Of course, they can get increased strength by just the increase in the material they get into the depth and thickness of the bar; but this only makes the joint more rigid, reducing the elastic limit, as compared with that in the rail. If there were no flexibility in the rail, none would be required in the joint. If a rail were so rigid that there was no deflection under the load, there would be no trouble with the rail ends. They could be supported. We believe that with our device a 75-lb. rail is abundantly heavy for the present weight of engines, cars and cargoes.

Yours truly, Wm. S. Brewster,
President Truss Rail Joint Co.

Chicago, Feb. 16, 1892.

[All the joints whose tests are reported in the accompanying table were located on fills, with gravel ballast, except the joint reported in the second line from the bottom, which was on gravel and cinder. In lines 4, 5 and 6 is given the results of a comparative test on 200 joints of each class, tested under the same conditions, and in service since May, 1889, excepting the Truss joint, which was put in about two months later. The average results shown by all the joints are summarized in the following table:

Kind of joint.	Average low, %.	Average in surface, %.	Ave. time in service, Mos.
Truss	10.2	89 8	27⅛
44-in. angle bar	32.0	68.0	28
32-in. angle bar	52.0	48.0	28
24 in. angle bar, 24-in. channel base-plate	59.4	40.6	14⅜
34-in. angle bar	97.0	3.0	57

Mr. Brewster also sends letters from roadmasters on the Galena division, the Iowa division and the Madison division of the Chicago & Northwestern, who have the Truss joints in use, and who state that the joints can be maintained for 25% to 50% less than other joints in service.—ED.]

MEASURING PAVEMENTS AND STREET CAR RAILS.

SIR: In answer to the query of "M. Am. Soc. C. E." in your issue of Feb. 13, my experience in the engineering departments of some ten American cities is that in all cases in measuring pavements on streets, in which there are car tracks, it has long been the custom to measure the space occupied by the rails the same as if it were pavement. This seems to be only just, as it can be readily seen that the labor and materials required in working around the obstruction is greater than would be required to pave the street if there were no rails. This is especially so where the girder or T rail set on chairs is used; for in these cases the foundation has to be supplied under the rails and around the chairs the same as under the pavement, and often to a greater depth, and the spaces around the peculiarly shaped rails (comprising all but about one-half inch in width for each rail) have to be filled with paving pitch or other material more costly than the material used in the wearing surface of the pavement itself. In the case of stone pavement it costs fully 25 cts. per sq. yd. more to pave the space around and between the rails than to pave the same area in an unobstructed roadway. Doubtless the expense in other kinds of pavements is fully as great. The custom of allowing measurements for space occupied by obstructions is also generally in practice in other mechanical works. For instance, in roofing, per square foot, it is customary to measure in as roof any obstruction such as a skylight which occupies less than 100 sq. ft.; in lathing and plastering, per square yard, one-half of all doors and windows is measured and charged as if the space were actually lathed and plastered.

Engineer.

THE LATE BURLINGTON BRAKE TESTS.

SIR: In the articles in your issue of Feb. 13, which describe the latest triple valve device of the New York Air Brake Co. and comment upon the results of the recent tests at Burlington, the impression is given that the release tests at Burlington do not possess much significance. In that article are also pointed out some constructive conditions which tend to permit leakage of air from the train pipe to the auxiliary reservoir when the release of the brake is attempted by increasing the air pressure in the train pipe with a moderate degree of rapidity. It is further suggested that such a slow method of releasing the brakes is unusual and does not occur in regular practice.

To anyone who has been a long time in active railway service, and who has observed the irregularities in the behavior of air-brakes which necessitates cutting them out, such a view of the function of releasing in an air-brake, will appear to very much undervalue its importance. A careful investigation of the causes which lead to the cutting out of air-brakes upon freight trains in service will show that in the great majority of cases the cause is failure to properly release.

Where, as in the automatic air brake, the application of the brake is dependent solely upon the release of the air confined in the train pipe, the certainty of securing an application of the brakes is not to be questioned. In releasing the brakes, however, the force which can be commanded for this purpose, is simply that excess of air pressure which can be accumulated in the train pipe, over and above that pressure which remains in the auxiliary reservoir, during the application of the brakes. When it is remembered that the volume of air required to fill the train pipe of a 50-car train is nearly 35,000 cu. ins., and that the greatest volume of high pressure air which can be conveniently stored upon the locomotive for use in release is only about 24,000 cu. ins., it will readily be understood that, after an emergency application, where the train pipe pressure is reduced to about 40 lbs., the admission of the air stored upon the locomotive to the train pipe for the purpose of releasing the brakes will not result in a train pipe pressure exceeding that remaining in the auxiliary reservoirs (about 60 lbs.) by more than a very few pounds. The fact must also be kept in mind that, in a long train pipe of such large volume, the air pressure at the rear end of the train can be elevated but slowly in any event, no matter what the pressure or volume of the stored air upon the locomotive may be.

Upon short trains, and at the forward end of long trains, there can be no doubt that in releasing the brakes the air pressure in the train pipe rises rapidly, so that the triple valve pistons are moved to the release position by a sudden and strong impulse; but at the rear end of a long train the train pipe pressure rises but slowly, and the triple valve pistons must be susceptible of movement through the medium of a gradually increasing train pipe pressure.

Any one familiar with the use of air brakes upon freight trains is aware that after air braked cars have been some time in service a train cannot be made up without the existence of leaks to the atmosphere from the train pipe and its connections, and this must be regarded as one of the conditions of practice. Such leaks, of course, further retard the rate of increase of the air pressure in the rear end of the train pipe for the purpose of release. If, in addition to such leaks from the train pipe, the construction of the triple valve is such as to present opportunities for leakage of air from the train pipe into the auxiliary reservoir, not only is the rate of increase of pressure in the train pipe further diminished, but the pressure in the auxiliary reservoir is increased, thereby requiring a still higher and more rapid increase of pressure in the train pipe to move the triple valve piston into the release position.

It is not purposed here to point out the special features of the construction of the new triple valve of the New York Air Brake Co., which have been partially enumerated in the above mentioned article in your journal; but it is sufficient to say that those who have had any considerable experience in the use and care of air brakes recognize a construction in this triple valve which precludes the securing of a sure release, without such modifications as will seriously interfere with the performing of other equally important functions.

There can be no doubt in the mind of anyone that the accumulations of dirt, grit and gum, which come largely from the lubricating oil, after a moderate time of service greatly interfere with the releasing of the brakes, and a triple valve of doubtful construction, which might readily be made to release when new, would be a constant source of trouble when in service. It is, therefore, in the highest degree essential that a triple valve should release without any difficulty whatever when it is new and in better condition than it will probably ever be again.

That the conclusions which have been drawn by many competent railway men in regard to the releasing qualities of the New York brake, from the so-called "unusual" release test applied at Burlington, were just, could hardly be questioned, even if this brake had not subsequently failed to release, in the trials upon the Lehigh Valley, under any of the ordinary conditions of practice.

Aliquis.

New York, Feb. 24, 1892.

[We think it was fully recognized in our article that the release test used at Burlington, though undeniably "unusual" under the conditions of actual practice, was an eminently proper and wise one as indicating comparative certainty of release. The later Lehigh Valley tests, at any rate, as reported elsewhere in this issue, have shown this beyond all question. But there is another fact which, on reviewing our former articles, seems to have been hardly assigned its due weight, namely, that the construction of the New York triple valve is such as to afford considerably more opportunity for leakage than does the standard Westinghouse triple. That the difficulty is insuperable is by no means clear, but it is one which must be experimentally proved not to exist, either in new or old triples, before the New York brake plant can stand in an entirely satisfactory position in regard to it.—Ed.]

The Japanese Government proposes to control all railway lines in the Empire. A bill has been submitted to the Diet for the construction of new lines aggregating 800 miles in length, connecting and completing the present railway system. The total amount of railway bonds to be issued is 50,000,000 yen, or about $56,000,000, at 5% interest. Of this amount $35,000,000 is to be used in the building of the new lines and the remainder in the purchase of private lines. The Government now controls the telegraph and cable lines.

An association for the promotion of profit sharing has recently been organized. The U. S. Labor Commissioner, Carroll D. Wright, is President, the two Vice-Presidents being President F. A. Walker, of the Massachusetts Institute of Technology, and Mr. N. O. Nelson, a prominent manufacturer in St. Louis. The Secretary and Treasurer is Nicholas P. Gilman, West Newton, Mass., author of a work on Profit Sharing. The Executive Committee consists of a railroad director, four manufacturers, who practice the system in their business, and a Professor of Political Economy in a Pennsylvania College. It is the intention to establish a bureau of information for the benefit of firms interested in profit sharing, the premium system and similar systems for uniting the interest of employer and employee, and by various publications and addresses before commercial and other clubs to promote the discussion and extension of such industrial reforms.

ENGINEERS' REPORT ON THE NEW WATER SUPPLY FOR NEWARK, N. J.

Owing to some differences of opinion between the city and company unusual interest attaches itself to the report made last week on the reservoirs and capacity of the water supply works recently built for Newark, N. J., by the East Jersey Water Co. This report was made to the Board of Street and Water Commissioners by Consulting Engineer A. Fteley, of this city, and Mr. C. E. A. Jacobsen, engineer for the board in connection with the new works. The report alleges that in the opinion of the engineers the daily capacity of the present system in a year of drouth could not exceed 35,000,000 gallons, whereas the contract calls for 50,000,000 gallons daily. According to the report the shallow flowage clause of the contract has not been complied with, the reservoir sites have not been properly cleaned of smaller vegetation, and some parts of the work are deficient in minor points of construction or finish. The conduit has not yet been reported on, as tests are yet in progress on parts of the line.

The magnitude of this work is so great and the points involved are of such general interest that the report is given below with but slight abbreviation in its first part, which recites the engineer's instructions and parts of the contract between the city company and which are of a general character.

For a proper understanding of the situation a brief description of the new works is necessary. A full description, with illustrations, will be found in Engineering News for Oct. 11, 1890, and Aug. 1 and 8, 1891.

The East Jersey Water Co. contracted in September, 1889, to build dams, reservoirs and conduits capable of delivering into the present reservoirs of the Newark water-works 50,000,000 gallons daily. The contract price is $6,000,000, but the company has been granted the privilege of selling to outside parties until eleven years after the date of the contract, or until Sept. 24,1900, all water above 27,500,000 gallons daily. For this privilege the company waits until 1900 for the payment of one-third of the contract price, or $2,000,000, paying but $4,000,000 upon the completion of the works, which must be by May 1, 1892.

The company has now nearly completed the works, which include two storage reservoirs on the head waters of the Pequannock River,an intake reservoir a few miles below, a steel pipe line 4 ft. in diameter and about 20 miles long leading to the present Belleville receiving reservoir, and a 36-in. branch steel pipe to the present high service reservoir.

Further description of the reservoirs and the bulk of the engineer's report is as follows:

This river [the Pequannock] has its source in the highest parts of the New Jersey highlands; its water-shed, especially above the point of intake, is very sparsely inhabited, and by far the greatest percentage of this area is covered by forests; it is substantially free from objectionable drainage, and the water to be delivered therefrom, in this respect, well complies in point of purity with the requirements of the contract as to the quality of the water to be supplied.

The watershed above the point where the water is taken into the conduit covers about 67 square miles. Three dams have been built: one at Oak Ridge, on the Pequannock River, forming a reservoir containing 2,500,000,000 gallons, which receives the drainage of about 27 square miles; one at Clinton, on a tributary of the Pequannock, called Moseman's Brook, forming a reservoir containing 3,500,000,000 gallons, which receives the drainage of about ten square miles; the third dam, below the outlet of Echo Lake, called the Macopin intake, is built on the Pequannock at the lowest point of the utilized portion of the watershed.

The reservoirs formed by the first two dams store a very large proportion of the water furnished by the corresponding drainage grounds.

The reservoir at the Macopin intake has sufficient proportions for the purpose of holding water at the head of the pipe conduit, but it has no practical value as a storage reservoir; consequently the lower part of the water-shed, about 30 square miles, from the two upper dams to the Macopin intake, can be utilized only to the extent of its natural daily drainage, and a very large proportion of the freshets will be wasted over the spillway of the dam.

Water-sheds have their local peculiarities and a strictly accurate estimate of their capabilities could be made only by a series of continuous gagings of the streams which receive their drainage, but in each case, in the absence of such gagings, comparison can be made with other water sheds not far distant and presenting somewhat similar conditions, with results which can give a fair idea of the capacity of the drainage area under consideration.

The drainage area above Oak Ridge is capable of furnishing more water than can be stored in the reservoir, but the Clinton reservoir has a small watershed, as compared with its capacity.

The Quantity of Water.

In view of good practice, and in accordance with the terms of the contract, our judgment of the capab lities of the system adopted must be based on its probable yield in such dry periods as have been experienced within our knowledge in similar circumstances, and we are of the opinion that the portion of the water-shed of the Pequannock included in the present system of works, with the reservoirs now built, although ample for the supply of 27,500,000 gallons, now required for Newark, could not, in a dry period, furnish a maximum daily supply for each and every day in the year of 50,000,000 gallons. On the strength of the comparison made as above stated, and from our present knowledge of the Pequannock watershed, we further believe that the capacity of the present system in a time of drought could not exceed 35,000,000 gallons for each and every day in the year.

Closely connected with the subject just mentioned is the question of the diversion of water referred to in the contract. We notice that several branches have been provided along the pipe line; we are also informed that water is to be provided for the running of mills located on the Pequannock below the Macopin intake. If connections are to be made with the branches mentioned or if water is to be furnished for the purposes aforesaid it is plain that in time of drought during the period that the company is empowered by the contract to divert water for its own purposes, the margin between the capacity of the present system and the volume of water due to the city of Newark would be dangerously small.

Construction of the Dams.

The two storage dams are built on a comman plan. They are formed of a heavy earth embankment containing in its center a wall made of concrete. An ample spillway and a gate chamber for the distribution of the water are also built in connection with each.

The foundation of the center wall has been, with two exceptions, extended to the solid rock, reaching at places considerable depth. The center wall is of sufficient thickness, and is made of concrete of good quality. The earth on each side of the wall has been laid in thin layers well compacted, and the embankments are protected by stone riprap. The dams proper are, on the whole, substantially built and the execution of the work has apparently been of a satisfactory character.

The Gate Houses and Gates.

No gate houses have been built over the gate chambers at Oak Ridge and Clinton dams. In general practice such structures are always built, especially in locations as much exposed to the weather as these are. They are, moreover, required by the terms of the contract and should be erected. The contract provides that "All parts of the work exposed to the eye should be of neat and workmanlike appearance without unnecessary ornamentation, and shall be of a thorough, proper, workmanlike onstruction, sound, solid and sufficient."

Parts of the work, which are exposed to the eye, do not comply with these requirements of the contract; a considerable proportion of the pointing, especially at the spillway of Clinton dam, has yielded to the action of the frost, and the top surface of the masonry of the gate-chambers and of their surrounding walls, which have been finished with a layer of cement mortar, already shows disintegration. These surfaces should be protected by copings. The crest of the spillway at Oak Ridge is formed of concrete only and should be protected with a capping of stone.

Each gate-chamber is provided with four pipes built in the masonry with as many gates in the dry chambers and flap-valves protected by an iron rack; although the valves are operated by appliances placed in the dry chamber, they are out of reach, and, notwithstanding the fact that the number of pipes secure to a large extent the continuous efficiency of the service of the flap-valves owing to the heavy pressure to which they may be subjected, are liable to become uncontrollable and could not be properly reached except at low-water in the reservoirs. This is a matter that should be remedied. The drainage of the gate-chamber at Oak Ridge is faulty and must be corrected.

Leaks in the Dams Not Serious.

Since the reservoirs have begun to fill up and the dams have been subjected to water pressure, small flows of water have appeared at different points along the outside of the embankments; also through the rock near the gate chambers and through the masonry wall of the Oak Ridge gate chamber. While there are at present no indications that these leaks are of a serious nature, they will, however, be kept under constant and careful observation, the result of which will enable us to determine their extent and character.

We have also observed that the surface of the outer slopes at Oak Ridge have become somewhat disturbed. These irregularities should be remedied, and we think that sodding should be used, especially on the outer berme, with proper drainage arrangements to protect the parts affected by the action of the water.

Reservoir Sites Not Properly Cleared.

The reservoir sites, including the specified space around the flow-line of high-water contour, has been well cleared and grubbed of all stumps, underbrush and shrubbery, and the several areas which formed the wooded parts of the sites have been carefully cleared and raked, all the stumps and other refuse were stacked and burned in accordance with the specifications. In regard to the smaller vegetation, but little effort has been made to remove the same.

The lower areas were flooded, leaving all the rank vegetation in its natural state. On the slopes and higher areas the grass was burned in spots, where it was sufficiently dry to permit it, leaving the stalks of the weeds standing. Some refuse and objectionable rubbish around the sites of the old dwelling and barns has not been removed in accordance with the requirements of the contract.

Your board is aware of these facts, and also of the failure of the East Jersey Water Co. to strictly comply with the requirements of the contract regarding the "clearing," notwithstanding the several communications of your board calling attention to the matter. It is obvious that this work cannot now be done without emptying the reservoirs.

The appearance of a part of the grounds near the dams, especially where extensive excavations have taken place, is not neat and workmanlike, and no attempt has been made to form regular slopes and to protect the same. This matter should be attended to.

The Shallow Flowage Clause Ignored.

The clause of the contract requiring the treatment of shallow flowage has been entirely ignored. Within the terms of the specifications, a large extent of the natural slopes can be left in their present condition, but at a number of places, especially on large areas of swamp extending along the streams running directly into the reservoirs and on extensive shoals and high grounds, the surface of which is close to high-water mark, excavations should take place, with proper slopes, in order to comply with the requirements of the contract. The necessary excavating can be done in summer time, when the level of the water in the reservoir is low enough to permit of it.

It should be stated that the engineers were instructed on Nov. 19, 1891, to report to the Board of Street and Water Commissioners "what is still necessary for the East Jersey Water Co. to do to complete and carry out the contract." This will explain the engineer's references to some minor points of construction and finish which the company doubtless proposes to attend to before asking that the works be accepted.

Regarding the cleaning of the reservoir sites it may said that the contract expressly includes "vegetation" among the trees, underbrush, etc., which are to be removed.

The shallow flowage clause of the contract is as follows:

With the exception of the necessary slopes and points where the formation makes it impracticable, the minimum depth of the reservoirs shall not be less than 8 ft. below the full water line.

Comparative rates per ton-mile are thus summarized in a recent address by Prof. L. M. Haupt on his project for an interior coast waterway:

	Per ton-mile.
Cost by horse power on canal	0.180 cts.
" C. R. R., N. J., 1890, nearly	1.000 "
" improved canals, cable traction	0.025 "
" lowest rail rates (Phila. and Erie)	0.300 "
" great lakes, lowest usual grain rate	0.015 "
" Lake Shore & M. S., lowest usual grain rate	0.400 "

The contrast is certainly notable, and indicates, as do many other facts, that while the days of small horse towage canals are numbered, the era of great ship canals is just beginning.

The net financial outcome of the Paris Exposition of 1889 was about $2,000,000, says the "Economiste Francais" in a late detailed analysis. The 125 concessions for cafes and restaurants produced about $450,000, and from concerts, etc., $45,000 was received. The total receipts of all kinds amounted to $10,000,000, as compared with $5,250,000 for 1867 and $4,635,000 for 1878, including in the latter a subsidy of $1,240,000 from the city of Paris. The expenses of the Exposition of 1889 were $8,000,000, while the expenditures in 1867 were $1,684,000, and $11,080,000 in 1878, including in the latter $2,800,000 spent in the erection of the Trocadero.

THE RENO SYSTEM OF TUNNELING FOR RAPID TRANSIT.

By J. W. Reno, E. M.

In designing this system of tunneling the writer s had in mind the following important conditions, and it might be well to state here that these conditions have also been recognized in the recent report of the New York Rapid Transit Commission:

1. The proper place for a rapid transit system that contemplates the running of trains at high velocities is below the surface of the street, where the train traffic will neither cause annoyance to the public nor damage to adjoining property.

2. The underground system should be as near to the surface as possible, but must not encroach upon the valuable sub-surface area occupied by the cable road structure, gas and water pipes and electric subways.

3. The method of driving the tunnel should be such that the street traffic will not be seriously interfered with, and the sub-surface structures adjacent to or over the tunnel must not be injured either during or after its construction.

4. The span of the tunnel roof should be supported by iron columns in order to give an open interior structure to the tunnel and admit of a single and positive system of ventilation.

The Reno system of tunneling consists essentially of two distinct operations.

1. The construction of the side walls of the tunnel in narrow plank-lined trenches which serve as a form or mold for a filling of concrete.

2. The excavation of the ground between the side walls by means of a flat roof shield which rests upon them, and is forced forward by hydraulic pressure. The placing in position of the steel roof and the erection of the iron columns and girders which support it in the center also form a part of this second operation.

In the engravings Fig. 1 shows an end elevation and section of the tunnel with the roof shield in position; Fig. 2 a side elevation and section of the same; and Fig. 3 a section through the cutting edge of the roof shield showing its construction more in detail.

It is not considered necessary to show in detail the method of construction of the sidewalls. In order to cause as little interruption to traffic as possible the sinking of the trenches for these walls will be prosecuted upon one side of the street at a time. When the trench is excavated to the required depth the filling in with concrete is begun, and as this proceeds the short cross streets which have the plank lining of the trench are gradually removed. Upon the top of the concrete wall thus made is laid a granite coping which will serve as a bearing for the steel roof girders. After the granite coping is laid the trench above is filled in with earth and the street pavement restored. It will be understood that this sidewall construction may be carried on far in advance of the tunneling operations which follow, so that the concrete will have abundant opportunity to set and season before being subjected to any pressure. The outside plank lining of the trench will be of creosoted lumber, and consequently indestructible in moist earth, but as the inside plank lining will be recovered subsequently, untreated lumber will answer for this purpose.

The roof shield, by means of which the ground between the tunnel walls will be excavated, consists, as shown in the engravings, of a horizontal steel plate 27 ft. by 7 ft. 6 ins. and one inch thick. To the under side of this plate is bolted the upper chord of a Fink truss through which extend eight cast iron cylinders which are also bolted to the roof shield and thus serve to strengthen it longitudinally. These cylinders are the hydraulic jacks which force the shield forward. Hooked to rings in each cylinder are pairs of suspension rods to which is hung, in the manner shown, the working bench or platform The hydraulic cylinders at each end of the shield rest freely in the sockets of heavy cast iron pressure plates having planed bottoms, and interposed between them and the stone coping of the sidewalls are a number of half-inch thick steel plates. These plates can be thoroughly lubricated and inserted in front of the pressure plates as the shield is advanced. In this way the weight of the shield will be evenly distributed and a good sliding contact obtained. The roof shield will probably never be subjected to the full weight of the material above it, for the reason that this material is held together and supported by its numerous pipes, etc., upon exactly the same principle that the foundryman has recourse to in strengthening the core of his molds.

The cutting edge of the roof shield is composed of a row of steel teeth set along the edge of the plate as shown in section in Fig. 3. Each tooth is backed by a stiff spring, and has a play of one inch in its socket. Now, if during the advance of the shield an obstruction such as a bowlder be encountered, the tooth or teeth in contact will be forced back, and in so doing can be made to ring an electric bell, or give some other signal to shut off the hydraulic pumps, thus preventing an injury to the shield. As the teeth are but three inches wide any obstruction will be accurately located, and may then be removed in the ordinary manner. while if a touth be broken it can be easily replaced.

It will be seen in Fig. 2 that the roof of the tunnel is formed of steel girders of special design shaped like inverted box troughs, which, when placed in position side by side, form practically a series of deck beams.

These roof sections can be made either by riveting a pair of channel beams, one to each side of a steel plate 1 in. wide, or by rolling them flat in one plate and then bending to the desired shape while hot. As their manufacture would call for a very large contract the latter plan would probably be the better one. The roof sections are in lengths half the width of the tunnel and are supported at their outer ends upon the stone coping, while their inner ends abut and rest upon the longitudinal girder carried by the central columns.

As the shield is advanced these roof sections are placed in position under the overhanging hood or plate, and are temporarily supported by the pair of riveted channel beams bolted, as shown, to the center post of the Fink truss. These pairs of channel beams slide upon the iron clamp which has been bolted to the last column erected, the upper pieces being cut away, as shown in Fig. 2, in order to admit of the insertion of the roof sections.

The operation of driving the tunnel may be described as follows: Fig. 2 shows the shield in the position to be advanced another stroke or cut. This will be accomplished by admitting water under pressure simultaneously to the eight hydraulic jacks, the pistons of which will then press against the adjacent roof sections. As these roof sections are immovable, the shield, together with the attached channel beams, must advance at a speed under perfect control of the man at the pumps. During this operation the men on the suspended bench will carefully cut down the heading and thus prepare it for the next stroke or cut of the roof shield. The suspended bench not only furnishes a very convenient support for the workman at this important point, but will also serve to hold the ground at the heading should it begin to run. It will be understood that the side walls make the occurrence of a lateral run at the heading practically impossible.

The trench needed for the concrete foundations of the central columns can be built the required dis-

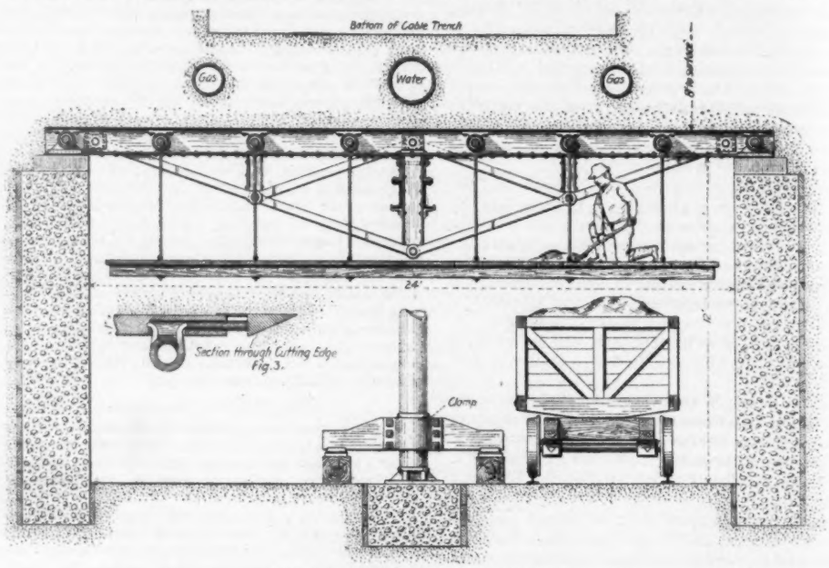

Fig. 1. Transverse Section of Tunnel.

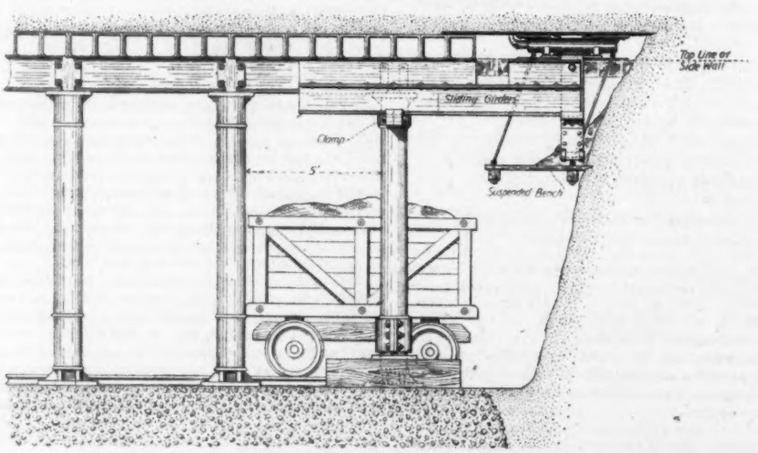

Fig. 2. Longitudinal Section of Tunnel.

A SYSTEM OF TUNNELING UNDER STREETS; J. W. Reno, Engineer.

tance in advance of the roof shield by driving forward a small drift for that purpose.

It is proposed to support the central columns by means of heavy iron clamps bolted at their bases as shown in the engravings. This will allow the foundation to be thoroughly packed under and up to the column base plates, so that when the concrete hardens and the clamps are removed there will be no possible chance for settlement. Of course, the tunnel roof sections could be supported temporarily by timber props, but these would take up valuable space at the heading and might impede the progress of the work.

In practice it will probably be found advisable to start a pair of roof shields in opposite directions at several points of attack along the tunnel line. This is made economically possible by the simple and inexpensive construction of the shields, and in consequence of this and also the fact that the side walls may be constructed far in advance of the subsequent operations, a very rapid driving will be assured.

The writer is well aware of the fact that this system of shallow tunnelling will have no application unless the two following conditions can be provided for with absolute certainty: 1st. There must be no possibility of any settlement of the ground over the tunnel either during or after construction. 2d. The metallic roof of the tunnel must be perfectly protected against corrosion.

It is proposed to meet the first condition in this way: As the roof shield advances it leaves a vacant space one inch in thickness immediately above the tunnel roof, which space will, of course, be immediately filled by the ground or sand above falling into it and loosely packing. We now have, instead of the inch thick vacant space, a stratum of loosely packed sand, perhaps four inches thick. Into this material, as soon as possible after it has formed, will be forced a grouting of liquid cement, which will be injected in the usual manner through holes in the roof sections provided for that purpose. This, in uniting with and filling the interstices of the loose sand, will form an impervious cover to the tunnel roof. It is not proposed to depend upon this, however, to protect the iron from corrosion. This, the second condition, will be provided for by applying to the exposed surface of each roof section before it is placed in position, a coating one-fourth of an inch thick, of a compound composed of Trinidad asphalt and wood pulp applied to the hot metal. This compound is very tough, is not subject to deterioration, and protected as it will be under a four-inch thick stratum of hydraulic cement, will last indefinitely and thoroughly protect the metal from corrosion.

In comparing the following estimates of cost of this tunnel system the reader may be surprised at the low sum total given, but it must be remembered that the method of construction described requires but little dead work, is very rapid and that the tunnel walls are built of a material costing $6 per cu. yd. as compared with $12 per cu. yd. for masonry. These walls, in addition to the advantage of low cost, will be a monolith without joint or seam from end to end and practically impervious to moisture:

Reno Tunnel System.—Approximate cost per mile.

Excavation of trenches for side walls, 12,320 cu. yds. each, @$2. 50 per cu. yd	$61,600
Concrete for side walls, 6,336 cu. yds. each, @ $6.00 per cu. yd	76,032
Granite coping for side walls, 8 ins. × 18 ins., @ 75 cts. per running foot	7,920
Excavation of ground between side walls, 65,700 cu. yds., @$1.00 per cu. yd	65,700
Concrete foundation for iron columns, 1,760 cu. yds., @$6.00 per cu. yd	10,560
880 cast iron columns, 1 ft. in diam. and 1 in. thick, weighing 1,115 lbs. each, @ 2 cts. per lb	19,624
Concrete floor for tunnel, 4,100 cu. yds., @ $6.00 per cu. yd	24,600
Steel roof sections calculated to support a load of 1 ton per sq. ft., 4,118.4 tons steel, @ $60.00 per ton	247,104
Asphalt coating for roof sections, @ $2.00 each	21,120
Longitudinal 15-in. I-beam for roof, 5,280 ft. 60 lb. per ft., @ 3 cts. per lb	12,672
Cement grouting for tunnel roof	20,000
Contingencies, and engineering and sundries	100,000
Total	$666,932

THE STATE ST. PLATE GIRDER BRIDGE.

[With inset.]

We present on our inset sheet this week the general plan and details of the plate girder highway bridge across Rock River on the line of State St., at Rockford, Ill. The bridge was designed by Mr. D. C. Dunlap, City Engineer, to whom we are indebted for the matter shown on our inset, and was built under the direction of the city's engineering force. The Massillon Bridge Co., of Massillon, O., had the contract for the superstructure, and the Rockford Construction Co., of Rockford, Ill., for the substructure. The total cost of the structure will be $57,236, of which $22,727 will be for the substructure and $34,509 for the superstructure.

The general elevation and plan of the bridge are shown in Fig. 1, on the inset sheet. It is 444 ft. 6 ins. long and consists of five plate girder spans, supported on masonry piers and abutments. The two shore spans are each 88 ft. 9 ins. long, and the three intermediate spans are 89 ft. long each. The substructure consists of four piers 6 ft. × 46 ft. 6 ins., under the coping, with a batter of 1 in 12 on the sides and of 3 in 12 for the ice cutter. These piers rest upon a grillage of two courses of 12 × 12-in. timber, supported by piles driven 15 ft. below the bed of the stream and 3 ft. between centers. The piles are surrounded by riprap. These four piers were built new, but the abutments of the old bridge were used for the new structure, with slight alterations and repairs. Each span of the superstructure consists of two plate girders 88 ft. long, 8 ft. deep, and ⅝ in. thick in the web, fixed at one end and supported on nests of steel rollers resting on cast iron seats at the other. Full details of these girders are shown in Figs. 2, 3 and 4. The distance between the girders, c. to c. of web, is 40 ft., and there are two 10-ft. sidewalks, measured from the center of the girder to the end of the brackets, making the total width of the bridge 60 ft. The girders of each span are stiffened by lattice girder struts at each end. The details of these struts are shown in Fig. 5.

Details of the floor beams are shown in Figs. 6 and 7. Those at the piers are 60 ft. long over all, 3 ft. deep and ⅜ in. thick in the web, and are supported on cast iron seats resting on the coping of the piers. The intermediate floor beams are 40 ft. long, 4 ft. deep and ⅝ in. thick in the web. The web is of one piece and is stiffened by 3 × 3 in. angles. Each beam is fastened to the main girder by 3½ × 4 × ⅝ in. angles. The floor stringers are of pine, 4 × 14 ins., supported by brackets made of 3 × 3 × 9 in. angles riveted to the web of the floor beams as shown in the drawing. Upon these are laid a course of 4 × 12 in. pine plank spiked to the stringers. Upon the flooring are laid two layers of roofing felt in tar, and upon this the pavement of cedar blocks 5 ins. thick. The whole is covered with a layer of tar and gravel 1 in. thick. The total width of the roadway between the guards is 37 ft.

The sidewalks, which are outside of the girders, are supported upon bracket plates fastened to the girder at each panel point by angles, and reinforced by gusset plates. The floor stringers are pine, 4 × 12 ins., and rest directly upon the brackets to which they are fastened by angles as shown in the drawing. The flooring is 2 in. pine plank spiked to the stringers. The guard rail is the ordinary Massillon iron bridge railing.

With the exception of the guard railing and the cast iron seats and lateral rods the entire superstructure is built of mild steel. The specifications required all steel to be made from commercial Bessemer pig stock and and not to have more than 0.085% of phosphorus in the finished product. With the exception of the material for rivets all material was required to have an ultimate tensile strength of not less than 60,000 lbs. and not more than 68,000 lbs. per sq. in.; an elastic limit of not less than 35,000 lbs. per sq. in., an elongation in 8 ins. of not less than 22% and to show a reduction of area at the point of fracture of not less than 45%. The steel for the rivets was required to have an ultimate tensile strength of not less than 56,000 lbs. and not greater than 60,000 lbs. per sq. in., an elastic limit not less than 33,000 lbs. per sq. in., an elongation in 8 ins. of 25% and a reduction at point of fracture of not less than 50%.

FREIGHT CAR ROOFS.

At the last meeting of the Northwest Railroad Club, Mr. J. C. Barber, Master Car Builder of the Northern Pacific R. R., read a short paper on the above subject. We abstract it as follows:

Enormous sums are annually paid out by railway companies in the way of damages for freight injured by water dripping through leaky car roofs. The writer recently examined at New York City 125 empty box cars belonging to different roads, and the same number at Chicago. The average proportion of cars with leaky roofs was nearly 2%. About the same proportion was found by inspecting 200 cars on terminal tracks at St. Paul. Most of the leaky roofs were the old style pattern, covered with canvas or roofing tin, or else the double-board roof, made with green lumber, which left open joints on shrinkage, or with the roof boards warped from breakage of the nails. The leaky canvas-covered roofs had holes punched through them, or else the canvas had decayed from the action of chemicals in the paint or from age. The tin covered roofs had many broken joints.

In the early freight cars the roofs were usually in a circular shape, supported with carlines or rafters, which were exceedingly light, not heavier than 1¾ by 3 ins., extending crosswise of car from plate to plate without central support. The covering was of narrow matched pine ¾-in. thick, laid longitudinally, secured at the crossing of rafter with common cut nails, and the whole covered with canvas or roofing tin and painted. The simplicity and fewness of parts of this old style roof was a desirable feature; and if the parts used in construction had been increased in strength, and the outside covering improved in durability by substituting galvanized iron or steel, it would have made a much more durable and less expensive roof than several of the so-called improved roofs of to-day.

However, on account of frail construction, and leaks due to nails working up through the canvas covering or the breaking of soldered joints in the tin, this style of roof was generally abandoned between the years 1862 and 1866. It will be noted that this style of roof, when old, was apt to sag at points near the center, forming low spots sufficient to hold pools of water.

After this roof came the double board roof consisting of a double course of clear pine strips 1 by 6 ins. in size, dressed on both sides with water grooves on face side. This roof was very popular, and gave, when well made, applied and kept well painted, fair satisfaction. It was reasonable in first cost and convenient to repair, and this roof is still used as a standard on quite a number of roads. But owing to the constant growing scarcity of clear pine and the increase in cost, which has nearly doubled in the last few years, the double board roof has been nearly abandoned, and the well known patterns of combination roofs substituted on account of their cheapness, both in first cost and maintenance, also their security against leaking.

Early patterns of combination wood and galvanized iron roofs were very defective. Later patterns, however, are not only cheaper in first cost by 20% than the double board roof, but are more durable and decrease by 30% the liability to leakage. They are now adopted as standard on perhaps half the railways of the country. Still more recent designs of this style roof promise still further improvements; and there are several styles of combination wood, fiber and paper roofs which seems to promise favorable results. A defect with some of the roofs now prominent is the large number of separate pieces. In one case these aggregate 338 per car, not counting nails, screws, washers, etc. In designing new styles of roofs an effort should be made to reduce this number.

STEAM TRACTION ON STREET RAILWAYS.

At a meeting of the Tramways Institute of Great Britain, at Bradford, England, in January, Mr. Vaux, General Manager of the Bradford Tramway Co., read a paper on "Steam Traction," of which we make the following abstract from a report in the "Contract Journal." He claimed that steam tramways have been commercially successful, and that where steam traction has been a failure it has been due to too light a track or unsuitable engines. The engine should be twice the weight of the car it has to haul, and the track must be suitable for the traffic. The weight of rails has been increased from 46 and 50 lbs. to 100 lbs. per yd., and the most approved track consists of heavy girder rails on 6 to 9 ins. of concrete. The type of engine most suitable for street railway work appears to be that nearly approaching the ordinary light locomotive, with surface condensers. The compounding of railway and street railway locomotives is progressing rapidly and with success in England and abroad. The Bradford Tramway Co. has now seven compound engines working daily in competition with simple engines of a similar make. These compound engines have a tractive force of 4,536 lbs., and were designed to haul 38,080 lbs. up a grade of 6.66%, or 250,880 lbs. on the level. The actual saving in fuel consumption is from 25 to 33%. A return made for the last half of 1891, comparing the performance of 4 compound and 4 simple engines showed a gain of 18 cts. per mile in favor of the former, and the company has been so satisfied that orders have been given for compounding other engines. The cost of operation of the Bradford Street Railways is 18.76 cts. per mile, including running, management and

maintenance. It had been stated that electricity would effect a saving of 6 cts. per mile, but he did not see how that was possible, as the cost of haulage on his lines was about 9 cts., and a saving of 6 cts. would hardly leave sufficient to pay the wages of drivers, cleaners and foremen. The cost of car repairs and conductors' wages is likely to increase rather than decrease, and it is not probable that the city will decrease the rent, cost of licenses, etc. He therefore failed to see how the economy claimed could be made.

In Engineering News of Oct. 24, 1891. we gave statistics of the comparative cost of operation of horse, cable and electric railways, but no figures have been given of the cost of steam traction on street railways in this country, for the reason, perhaps, that such traction is generally confined to suburban and country lines, and its use on city streets comparatively rare. The Baldwin Locomotive Works, Philadelphia, Pa., built last year a four-cylinder compound steam motor for experimental service on street railways, and have built a similar motor for the Wilmington Street Ry. Co., Wilmington, N. C.

THE MOVABLE SIDEWALK RAILWAY.

One of the most original and complete departures in the line of transportation at the Chicago Exposition will undoubtedly be the "Multiple Speed and Traction Railway," or "Movable Sidewalk" railway, of which we have already given descriptions, and which we now illustrate as embodied in an experimental road at Jackson Park, Chicago. This section is built as a preliminary evidence of what can be accomplished by the longer road which it is expected to build for use at the exposition. The experimental section (described more fully in our issue of Jan. 16, and a general view of which appears in Fig. 1) is an endless track 900 ft. long, having curves of 75 ft. radius.

Fig. 2 is a transverse section of the endless railway train, as constructed at Jackson Park, and Fig. 3 is an outline drawing of the electric motor employed. Fig. 4 shows a proposed extension of the principle of the device which has not yet been applied in practice.

In Fig. 2 it will be seen that the side platform at the left, called the first or slow-moving platform, is carried on the axles of the wheels and is entirely disconnected from the central or "fast" platform which carries the seats. This latter is carried on flexible rails, resting on the peripheries of the wheels, as the wheels rest on the rails, and hence is propelled forward with just twice the speed of the wheels themselves and of the side platform resting on their axles. The speed of the latter is 2½ to 3 miles per hour or a very easy walking speed, and that of the seats just double that.

Hence it is never necessary for the train to stop in order to enable a reasonably agile passenger at least (and it is claimed any passenger) to get on and off. He has only to take a step or two alongside of the iron posts at the left, till he acquires the speed of the post, place his hand upon it, and step upon the slow platform; and then he has only to take a step or two forward on the latter, place his hand on the first vacant seat, and step onto the central platform, where he finds himself moving considerably faster than the ordinary horse car, since he loses no time by stops.

The train carrying the side platform consists of trucks 12 ft. long, 5 ft. 9 ins. wheel base, the wheels being 18 ins. diameter. The journals, carrying but little weight, as the seats do not rest upon them, are 1¼ by 4 ins.

The fast or main platform, which is connected with the wheels by gravity and friction only, is also made up of 12-ft. sections, 5 ft. 10 ins. wide. Each section carries four seats, seating three passengers each, so that the seating capacity is just one passenger per lineal foot of track, and the seated capacity per hour exactly equal to the speed in feet per hour. There is a 10-in. space at the side of the seats, along which passengers can pass from seat to seat.

The flexible steel rails on which this platform rests are 4 ins. deep and ¼ in. thick, and each of them is continuous or endless. It is rather vaguely stated that "they are made in convenient sections, easily handled and welded or riveted at the site." They are carried in brackets securely fastened to the framework, and each bracket contains a block of rubber to serve as a spring. Between this rubber block and the rail there is a steel shoe which fits over the rail, and through which it slides when the cars adjust themselves in entering or leaving curves. It will be seen that the cars are perfectly free to move forward or back on the rails, as are the rails on the wheels, and that the slight difference in the speed of the rails, due to one being (in a complete circuit) 3⅛ × 2 longer than the other, can adjust itself by the rails creeping through the sockets (or of course by their slightly slipping on the wheels if it happens so). Expansion and contraction is not specially provided for. About 1⅛ in. lateral play on the wheel tread is deemed sufficient. As the linear expansion will be over ⅝ in. per 100 ft., for a difference of 50° F. in temperature, it would hardly seem as if this provision was adequate, but it is claimed to be, and if not, other provisions can be made for it.

The fast platforms are connected together by close couplings, to insure uniform movement, but it will be evident that each 12 ft. section is propelled independently. The fast platform weighs, complete, 100 lbs. per lin. ft. The slow moving platform, complete with wheels, weighs 133 lbs. per lin. ft.

The complete train, therefore, weighs 233 lbs. per lin ft. empty, to which about 150 lbs. per ft. should be added for the passenger load. The friction has been assumed at 15 lbs. per ton, which is about the ordinary horse car friction. This amounts to 34½ lbs. per 12 ft. section, which at 3 miles per hour amounts to 0.276 HP. per 12 ft. section, or 24.84 HP. for the present experimental train of 75 cars.

The space between adjacent ends of platforms is bridged by iron plates, fastened to one and overlapping the other. The vertical crack between the fast and slow, and the slow and stationary platforms is guarded by coarse rubber strips.

FIG. 1. EXPERIMENTAL SECTION OF THE MULTIPLE SPEED RAILWAY AT JACKSON PARK, CHICAGO; Max E. Schmidt, Engineer.

The motive power is a stationary electric plant. The motors (Fig. 3) are frequent and of small power, and are applied direct to the axles of the motor cars, which are placed at equidistant intervals in the circuit. Each motor pulls, and never pushes. To insure this in setting up the continuous train the platforms are placed end to end, the drawheads abutting against each other. They are then all coupled up with closed links, except the motor car. An open link of about 6 ins. in length is used in coupling the motor car to the platform immediately preceding it.

The feeder wire is placed beneath the platform in order that all danger from accidental contact with it may be avoided. Current is carried to the motors from this wire by means of a trolley wheel and pole attached to the lower side of the slow moving platform. A return circuit is secured by connecting the steel rails of the fixed track with bonds in the same manner as an electric street car track construction. The running of the entire railway is controlled at the controlling station, where, by the single turn of a

switch, all motors are started and stopped simultaneously. Within easy reach of the electrician operating the railway there is a main switch, a reversing switch and rheostats, besides the automatic circuit breaker above referred to. The motors cost about $50 per HP. and the wire circuit complete $850 per mile.

On the experimental line the motive power is provided by three Thomson-Houston electric motors like Fig. 3, each of 15 HP. This gives for the operation of the 75 cars, of which the line is composed, 30 HP., an amount which experience is said to indicate is more than three times what is actually required.

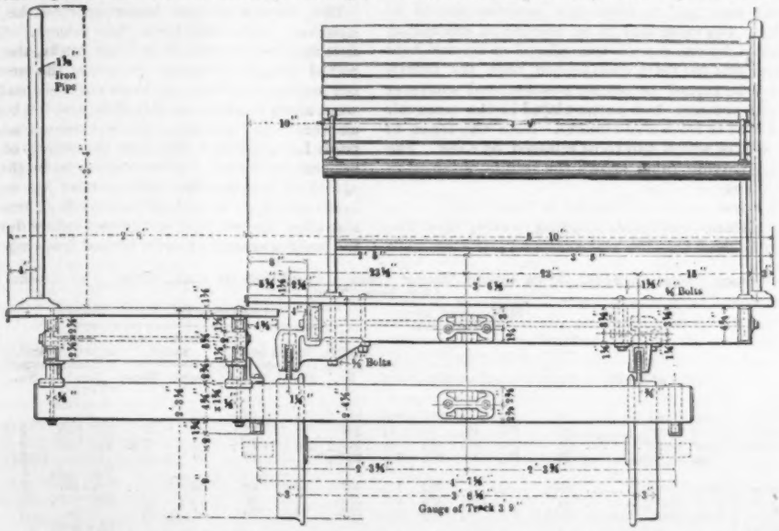

FIG. 2. TRANVERSE SECTION OF MULTIPLE SPEED RAILWAY, SHOWING BOTH PLATFORMS.

Fig. 4, as already stated, illustrates how the principle of the multiple motion may be extended to a third, fourth or fifth platform. In this way, if we assume a differential speed of 3 miles per hour to be safe, 9, 12, or 15 miles per hour may be attained, and yet leave to each passenger the power of entering or leaving the train at any point while in motion. It is claimed, and we do not doubt with truth, that active men find no difficulty in entering or leaving the train with a differential speed of 9 miles instead of 2¼ to 3; but, on the other hand, for general city transit, where suitable provision must exist for carrying all sorts of persons, speeds of even 2½ and 5 miles per hour would hardly insure that weakly or clumsy people would be able to use it, if we may judge from the number of persons who seem utterly unable to enter or leave a horse car until it has come to a dead stop. For transit within a great exposition, however, where the patrons are all of a selected and vigorous class, this objection is of far less moment, and experience there will enable general possibilities to be better gaged.

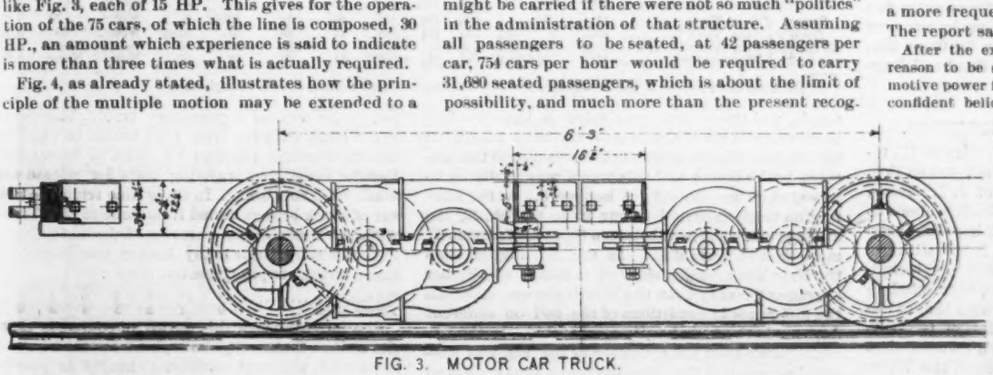

FIG. 3. MOTOR CAR TRUCK.

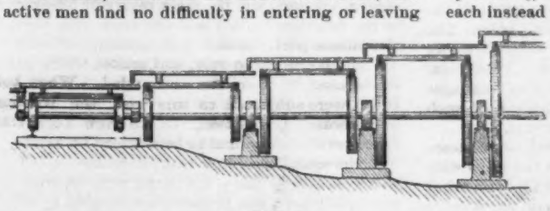

FIG. 4.

The capacity of such a continuous train is undoubtedly great, yet not so great as might at first sight appear. At six miles per hour, 5,280 × 6 = 31,680 seated passengers per hour will pass a given point, which is equal to 317 car loads of passengers crowded into cars at the Brooklyn Bridge rate of 100 each. This would amount to a little less than 80 four-car trains per hour, which is just double what is now being carried, but much less than half what might be carried if there were not so much "politics" in the administration of that structure. Assuming all passengers to be seated, at 42 passengers per car, 754 cars per hour would be required to carry 31,680 seated passengers, which is about the limit of possibility, and much more than the present recognized limit of possibility or than has ever yet been in fact realized in any part of the world.

This capacity, however, has been and is now realized on the experimental track, and it is obvious that it can be still further increased at slight cost by making the seats hold four or five passengers each instead of three. On the other hand, there is the difficulty that a break-down of any car or essential part thereof requires the stopping of the entire train until the break can be repaired. Experience alone can indicate how serious this difficulty is, but it may reasonably be hoped to reduce it to small dimensions on lines of moderate length. Otherwise than for this obstacle it will be apparent that there is no natural limit to the length of circuit which can be advantageously operated by the endless train.

We can testify from personal observation that the motion of the train on the experimental circuit is smooth and easy, much more so than is usual with street and cable cars, and that entering and leaving the train is perfectly easy to a moderately active person. An experiment on a larger scale is fully warranted by past experience, and we shall watch its results with great interest.

The "movable sidewalk" railway is the joint invention of Mr. Max. E. Schmidt, C. E., and Joseph L. Silsbee, architect, both of Chicago. The device is now controlled by the Multiple Speed & Traction Co., A. F. Walker, President, 54 Lakeside Building Chicago.

OPERATING EXPENSES AND RECEIPTS OF THE CITY & SOUTH LONDON RAILWAY.

The results of operation on this road for the hal year ending Dec. 31, 1891, are of much interest on account of the extent to which the road has been held up as a model for rapid transit railways in this country and the fact that it is the first experiment ever made with electric traction under circumstances approaching those in which an ordinary locomotive is used. The line is three and one-sixth miles long, and as yet has a very thin traffic. W abstract the principal figures for the half year, as follows:

	Per mile.	Total.
Gross receipts	$31,000	$98,178
Operating expenses	23,750	75,252
Net earnings	7,250	22,926
Interest on bonds	6,600	20,874
Earnings available for dividends	650	2,052
Passengers carried June 31 to Jan. 1		2,719,055
Increase over previous six months (145)		336,712
Average fare per passenger (excluding season tickets)		3.4 cts.
Average no. passengers per train		49.3
Average receipts per train mile		53 cts
Average operating expenses per train mile		40 cts.
Percentage operating expenses to total receipts		76%
Percentage of operating expenses of railway alone (not including expenses of operating station elevators) to total receipts		66⅓%
Cost of motive power per train mile		15½ cts

The rolling stock has been increased by two new locomotives and six new cars. The fourth engine and dynamo are being built for the generating station. With these additions it is expected to provide a more frequent train service during the rush hours. The report says of electric traction:

After the experience of the past year there is every reason to be satisfied with the use of electricity as a motive power for the working of this railway and for a confident belief that when all the details are fully perfected it will be found to be at once safe convenient and economical.

The chairman of the Board of Directors, Mr. Chas. G. Mott, also spoke as follows at the shareholders meeting concerning electric traction, according to the "Railway News" abstract of the proceedings:

Looking at the locomotive expenses—electricity versus steam—their locomotive expenses were 7.88d. (15¾ cts.) per train mile. Now, the locomotive expenses of the main lines of the country, such as the Northwestern, Great Western, Midland and the Great Northern were, he believed, something over 9d. (18 cts.) per train mile during the past half year, as against their 7.88d. That was not all. Their charges of 7.88d. included the price paid for coal, which covered all the carriage from the collieries to their depot. In most of the other companies the price of the coal was charged at the ruling prices at the pit's mouth, so that if they were to deduct the price of the carriage the expenses would be reduced to 6.6d. per train mile. The advantages which they claimed for electricity over that of steam is that, as a motive power, it was safe, convenient and economical. They had proved it was safe and convenient, and that it was economical he would say that they could carry five persons at the same rate as the steam railways could carry three. He was very much surprised on reading the report of the Metropolitan Ry., that Sir Edwin Watkin had stated that he had studied the question of electricity, but that he understood that an electrical engine could only take and draw its own weight. Well, all he could say was that their engines at the present time were always taking more than three times their own weight and sometimes four times their own weight, and that up an incline of 1 in 27, with a reverse curve of 132 ft. radius. He was quite sure that Sir Edward had not an engine on one of his railways that could do the same work. Then their average speed working at the present moment is 13 miles an hour, including stoppages, being about 2 miles an hour faster than the trains on the Inner Circle of the Metropolitan Railway. Electricity is as yet in its infancy, and they would therefore see that electric power in the future was not a matter which the engineers of to-day could afford to despise. He had had a large experience in the working of steam railways in this country, and he could not help feeling—from facts which they had learned during the past year—that everything tended to show that at no very distant date electricity would be

very largely substituted for steam over the railways of the world.

While the figures given above for the comparative cost of steam and electric traction may look well on their face, it is well to remember the great difference between the weight and speed of trains hauled on the ordinary railway and those of the City & South London Ry. The trains on the latter consist of only three cars, and as the clear diameter of the tunnels is only 10 ft., the cars are by no means large. It is of interest to note in this connection that in 1890 the average expenses per train mile on the Manhattan Elevated Ry. in New York City were 66 cts. (against 40 cts. above), while the earnings were $1.24, against only 54 cts. above. The Brooklyn Elevated road, however, which is operated under conditions more like those of the City & South London road, showed in 1890 average expenses of only 34 cts. per train mile and average earnings of 57 cts. This is 6 cts. smaller expenses and 4 cts. greater earnings than those of the London road.

From the above figures it must be concluded that while the economy of electric motors over the steam locomotive has been greatly exaggerated, the difficulties in the way of the successful operation of electric elevated or underground railways have also been overestimated. For city transportation lines of this class the experience in London seems to indicate that electricity is even now about able to hold its own against steam on the score of cost alone, without considering its other advantages. Nothing in the operation of this road, however, which has been made public affords any foundation for the opinion expressed by the chairman of the company above, that electricity is soon to take the place of steam in general railway service.

At the semi-annual meeting of the City & South London stockholders some dissatisfaction was expressed that the traffic returns were so small. Nevertheless the directors of the company were empowered to proceed with their plans for an extension which is to pass underneath the river by two new tunnels and run thence via King William St., Prince's St., Moorgate St. and City Road to Islington.

THE LEHIGH VALLEY BRAKE TESTS.

The brake tests on the Lehigh Valley R. R., referred to in our last issue, were carried out on Feb. 16, 17 and 18, under the direction of J. I. Kinsey, Master Mechanic of the Lehigh Valley shops at Easton, and D. L. Barnes Consulting Engineer. Two 50-car trains were tested, one fitted with the equipment of the New York Air Brake Co. including its latest design of triple valve, illustrated in our issue of Feb. 13, and the other with that of the Westinghouse Air Brake Co. In a few of the tests of the New York brake the engineer's valve of that company was used, but in most of them the Westinghouse engineer's valve was used. The cars were empty box cars just out of the shop, fitted with Gould couplers and National hollow brakebeams. The brake shoes were of cast-iron and unworn; brake shoes on engine and tender were in good condition.

The original intention was to carry out a previously determined schedule of tests with the New York brake on Feb. 16, and follow with the same tests on the Westinghouse brake on Feb. 17. The first day's tests, however, were not accepted as satisfactory by either of the competing brake companies, and the New York brake was therefore tested again on Feb. 18. Of the tests on Feb. 16, the official report says:

> These tests were very unsatisfactory owing to the disagreement as to the nature of the tests to be made, the presence of too many men on the engine and the refusal of one of the companies to take part in the proposed plan for tests under all conditions of service. Therefore a new plan was ordered by the officers of the road to be followed strictly, with only one disinterested party on the engineer's side, with the engineer, and one representative of each brake company on the fireman's side. Mr. Elder, brake expert of the Pennsylvania road, was chosen for the disinterested party on the engine and written instructions were furnished him and were strictly followed on the succeeding tests.

The schedule of 10 tests included four emergency stops with the 50 car train from speeds of 20, 30 and 40 miles per hour, with a release test after each stop; standing tests with 50 cars for release after emergency application, and to determine how many cut out cars the emergency application would pass; and standing tests with one car for graduation, for holding pressure in cylinder, and for obtaining service application without emergency.

Principal interest of course centers in the stops with the emergency application and in the various release tests.

Running Tests.—Emergency Application.—All these tests were made while running on a 47 ft. per mile down grade. The engineer's orders for making a stop were that the train pipe pressure should be 70 lbs. The valve was to be thrown to emergency position for one second, then placed on lap and kept there until the train was stopped, then the handle was to be turned to release position, and whatever excess pressure had accumulated in the reservoir was used to release the brakes. Note was taken of all brakes which had to be released by hand. The accompanying table shows the results obtained in the emergency stops.

The first noticeable feature in these stops is the long distance run before stopping in every case. The records show that the brake cylinder pressures were largely due to the way in which the engine was handled. If it was pulling out hard at the time the brakes were applied, then a greater shock was produced. Owing to the varying conditions, the shocks given are not comparable. There is no apparent reason for the wide variation of shock under what seems to be the same conditions, otherwise than that of handling the engine as just mentioned. The tightness of the train was tested and found to be such as would not interfere with a proper action of the brakes.

The feature of most importance in the trials, however, was the tests for release. Of the first day's tests of the New York brake, the official record says: "On these four runs the record was not kept accurately. A New York air brake man went along the train at each stop, and ten brakes in all were reported stuck. On the second and third trials Lehigh Valley men kept the records of brakes released by hand." In the table we have, therefore, placed an interrogation mark (?) after the report of brakes stuck on in each of the first day's trials, and also after the last trial on the concluding day when the train was started with brakes dragging to get

Emergency Stops on 47-ft. Down Grade, 50-Car Train. Condition of Rail, Good; Car Brake Shoes, Cast Iron, New.

	Kind of brake.	Speed, miles per hour.	Slide-meter movements, ins. Rear car. No. 1.	Rear car. No. 2.	Front car. No. 1.	Front car. No. 2.	Length of stop, Ft.	Pressures, lbs. Train pipe. Front.	Train pipe. Rear.	Brake cylinder. Front.	Brake cylinder. Rear.	Breakages (cars numb'r'd from head.	Brakes stuck. No.	P. c. efficiency of brake.
Stops from 20 miles per hour.	New York	20	5¾	....	11¼	9½	232.5	70	68	60	....	Tender coupling links	1	6.59
	New York	21	2¾	4⅝	⅛	⅛	254	70	71	62	57	Tail bolt.	4	6.65
	New York*	21	2½	9⅝	1⅜	⅛	246½	77	75½	66	62½	Tail bolt.	5	6.84
	Westinghouse	20	9⅝	8	1¼	1½	225⅝	71	69	60	55	None.	None.	6.93
Stops from 25 miles per hour.	New York	25¾	⅛	....	1⅝	1¼	407	70	68	50	....	Tail bolt car 15.	2?	6.28
	New York	28	1	14⅞	1⅞	1⅝	474	71	69	60	57	Tail bolt.	11	6.32
	New York*	28½	6	8⅝	1¾	1½	460½	72	70	61	57	None.	?	6.73
	Westinghouse	24	16	19¾	⅛	⅞	323	72	70	60	55	Tail bolt, car 25.	None.	6.62
Stops from 30 miles per hour.	New York	32	⅛	....	1⅝	1½	663	68½	65	48	....	None.	6?	5.91
	New York	34	1	4½	1½	1¾	714½	71	69	60	57	None.	9	6.16
	New York*	34½	3⅛	7¼	2	⅞	657½	72¼	70	62	58	None.	21	6.84
	Westinghouse	30	16⅞	24¾	⅝	1¼	560½	71	70	60	55	Tail bolt, car 26.	None.	6.14
Stops from 40 miles per hour.	New York	41	⅝	....	2⅞	1⅝	1,181	67	65	47½	....	None.	2?	5.43
	New York	40½	2	3⅝	2¼	2¼	1,056	71	70	60	57⅛	None.	15	5.91
	New York*	41½	1⅛	6½	2¼	2	1,076	70	68	60	57	None.	None.	6.06
	Westinghouse	41½	7⅛	2-12-3	2⅛	1⅝	1,128½	71	70	60	55	None.	None.	5.68

* In these tests the New York engineer's valve was used; in all others, the Westinghouse.

ample, and the obvious conclusion is that the low percentage of efficiency (which we have computed for the last column of the table) was due to the unworn brake shoes; and this result was really to be expected as we pointed out last week. At the Burlington tests, reported in our issue of Feb. 13, the average efficiency was between 8% and 9%, about 2% more than in these stops. In the Burlington tests the New York brake showed a somewhat higher average efficiency than the Westinghouse, although the difference in conditions of the rail on different days made the tests hardly comparable. In the Lehigh Valley tests the condition of the rail was uniformly good, and the Westinghouse brake showed an efficiency about 0.66% higher than its competitor, on the average.

The variations in the readings of the pressure gages are claimed in the official report to be partially due to variations in the gages. "It is seldom that they agree within 2 lbs., and one gage of this lot was 5 lbs. too low."

It will be noticed that with one exception all the breakages occurred in the draw-bar tail bolts. The record states that these breakages occurred either under the head or in the keyway, and the metal appeared to have been overheated. The breakages occurred, however, without indications of such severe strains as occurred at Burlington.

Doubtless the most surprising result of the tests is the shocks which were obtained in the stops with the Westinghouse brake. This is the first time that such shocks have occurred in tests of the present Westinghouse quick-acting brake, and it is somewhat of a puzzle why they were obtained. It will be noticed that no record is given of the rapidity of application of the brake or the length of time between movement of the engineer's valve and application on the last car. An electric instrument was arranged to make an automatic record of this point, but it was connected to the brake lever instead of to the piston rod; and as some of its indications were manifestly incorrect, all were rejected in making up the official record.

The official report comments as follows on the shocks:

> The wide variation in the shock in the rear car was

out of the way of a passenger train. This leaves seven stops with the New York brake, in which the record of brakes released by hand is undisputed. Besides these, two standing tests for release were made with this brake. In these nine trials the number of stuck brakes varied from none to 21. The cars with the stuck brakes were recorded, and the following table shows how many brakes stuck once, how many twice, etc., in the seven stops:

Brakes	16	10	3	9	6	1	4	1
Times stuck	0	1	2	3	4	5	6	7

The importance of this record, of course, is that it shows that brakes which stuck at one time went off at another, although handled as nearly as possible under the same conditions in all the stops. The Westinghouse train had not a single stuck brake in any stop.

The two standing tests for release were made under different conditions from the running tests. The train was the same, 50 cars. In the first test all the air was exhausted from the train pipe through the emergency port, and the main reservoir pressure of 90 lbs. was then turned into the train pipe through the release port. Brakes were pumped off with the Westinghouse pump only, and brakes which had to be released by hand were recorded. When both trains were subjected to this test, the Westinghouse brakes all released. In the New York train 16 brakes stuck and had to be released by hand.

In the second standing test for release, all the air was discharged from the train pipe through the emergency port, and brakes were released by admitting air from main reservoir at 105 lbs., with engineer's valve in running position, and both the Westinghouse and New York pump running. As soon as train pipe pressure reached 70 lbs., brakes still sticking were released by hand and the number recorded. Under these conditions all the Westinghouse brakes released, but 21 brakes in the New York train were still on when the train pipe pressure reached 70 lbs. Remembering that the pressure in the brake cylinder in an emergency application is about 60 lbs., it seems clear that the New York triple valves must have leaked air from the train pipe to the cylinder and reservoir in this test as fast as the pressure rose in the train pipe.

In the standing test to see how many cut-out cars the quick action could jump, the 50-car train was used, and ten cars, Nos. 15 to 25, were cut out. The emergency application was made, and if not obtained at the rear of the train car, No. 24, etc., was cut in until it was obtained. On the Westinghouse train, with rapid repetition of tests from 10 cars cut out down to 4 cars cut out, the emergency application was able to pass 4 cars. On the New York train the same test was made from 10 cars cut out down to 2 cars cut out, and the emergency application passed 2 cars. It was then tried to make it pass 3 cars by charging train pipe and reservoirs to full pressure of 70 lbs., but unsuccessfully.

A standing test was also made with one car to see if the emergency application would be obtained by placing the engineer's valve in service position and letting all the air out of the train pipe. With the Westinghouse brake no emergency application was obtained. With the New York brake and New York engineer's valve the emergency application took place on the first trial.

Tests of Tightness of Valve and Brake Piston.—This was a one-car standing test to determine the ability of each brake to maintain a steady pressure in running down grades. The service application was made to obtain 27 lbs. pressure in the brake cylinder, and the train pipe and cylinder pressures were again observed at the expiration of 4 minutes. With the Westinghouse brake the cylinder pressure increased to 47½ lbs. in 4 minutes, while train pipe pressure fell from 60 to 52 lbs., so that 8 lbs. reduction in the train pipe put 20½ lbs. in the cylinder. With the New York brake the 27 lbs. pressure in cylinder remained at that point for 4 minutes, while the train pipe pressure fell from 60 lbs. to 54 lbs. The official record states that the reservoir pressure probably decreased with the cylinder pressure through leakage of the triple valve piston.

Graduation Tests, made with one car, standing, consisted merely in making successive reductions of train pipe pressure and noting increase of cylinder pressure at each. The Westinghouse engineer's valve was used in both cases. The practical value of a one-car test as an indication of the ability of the brakes to graduate in a proper manner seems so small that we do not print the results. Apparently they do not differ much from those obtained with a 25 car train at Burlington, which we showed by diagram in our issue of Feb. 13.

UNITS FOR THE MEASUREMENT OF WATER FOR IRRIGATION.

In the measurement of water for irrigation in this country there has never been a unit common to all sections. The "miner's inch", or the quantity discharged through an opening 1 in. square under a given head has generally been used, but with different heads so that the quantity of water discharged has been variable. According to the figures given below, the miner's inch in California is taken to equal $\frac{1}{50}$ cu. ft. per second, or 1,728 cu. ft. per day, and in Colorado a little less than $\frac{1}{40}$ cu. ft. per second, or 2,160 cu. ft. per day. Recently the "acre-foot" seems to be coming into favor, especially for stating the capacities of storage reservoirs. This, as is evident from the name, is the amount of water necessary to cover an acre of ground to a depth of 1 ft. or 43,560 cu. ft.

At the Irrigation Congress held at Salt Lake City, Sept. 15 to 17, 1891, Mr. C. L. Stevenson, C. E., of Salt Lake City, presented a table of equivalents for cubic feet per second, California and Colorado miner's inches. These figures, with others, have been published in a pamphlet entitled "Irrigation Statistics of Utah," etc., from which we copy as follows:

1 cu. ft. per second equals:

2 acre feet in 24 hours.	7.5 gallons per second.
60 acre feet in 30 days.	449 gallons per minute.
180 acre feet in 3 months.	50 California inches.
720 acre feet in 1 year.	38.4 Colorado inches.

100 California inches equals:

4 acre feet in 24 hours.	15 gallons per second.
1 acre foot in 6 hours.	900 gallons per minute.
120 acre feet in 30 days.	77 Colorado inches.
360 acre feet in 3 months.	2 cubic feet per second.
1,440 acre feet in 1 year.	

100 Colorado inches equals:

5⅓ acre feet in 24 hours.	19.5 gallons per second.
1 acre foot in 4.2 hours.	1,170 gallons per minute.
155 acre feet in 1 month.	2.6 cubic feet per second.
465 acre feet in 3 months.	130 California inches.
1,860 acre feet in 1 year.	

All figures where miner's inches are used must be regarded as of doubtful value for comparative purposes unless a full definition of the miner's inch used is given. The character of the orifice, as well as the head in inches, needs to be known. The uncertainty of the term was set forth at some length in our issue of Dec. 6, 1890, where it was shown that while a 6-in. head had most often been used in 146 legal definitions in several states and territories, yet that in 97 cases it had not been stated whether the head was measured from the top, center or bottom of the orifice, nor was the thickness of the measuring box given. In Colorado the statutes provide, unless changed since 1887, for a 5-in head, while in California, or at least the southern part of the state, a 4-in. head now seems to be generally used.

THE GERMAN TELEGRAPH AND TELEPHONE SYSTEMS.

The telegraph system of Germany, according to the "Deutsche Bauzeitung," from which we abstract these data, comprises 67,434 miles of line, with 228,200 miles of wire and 18,121 telegraph offices. The total length of underground lines, connecting 243 cities, is 3,928 miles with 26,650 miles length of wire, while the subaqueous lines of the government amount to 1,866 miles, with 4,558 miles of wire. It is worthy of mention that Mannesmann tubes have been used extensively as poles for surface work. They were employed as such for the first time at the construction of the line from Bagamoyo to Tanga, in the German East African territory, 118 miles in length.

There are at present 275 cities with 58,500 telephone stations, against 223 cities with 50,500 stations the year before. The city of Berlin alone has 16,300 of the latter, which is more than the total number of telephone stations existing at the time in France. Hamburg has about 6,200, Dresden 2,400 and Leipzig 2,250 stations. The telephone system extends over 5,653 miles with 54,053 miles of wire. The number of daily messages amounts to 640,200. For Berlin alone it amounts to 238,870, or 14.6 for every telephone station in the city. The use of the long distance telephone has been considerably increased.

ELECTRIC TRANSMISSION OF POWER AT HERRENWIESEN-BULACH, SWITZERLAND.

The turbine plant at Herrenwiesen-Bulach, Canton Zurich, Switzerland, which has recently been completed, utilizes a small tributary of the Rhine, the Glatt, for the electric transmission of power, after the plan adopted at Lauffen on the Neckar. The "Zeitschrift des Vereines Deutscher Ingenieure" gives the following details of the work:

Three canals had to be constructed; the first at the left side, in 714 ft. of length has a fall of 36 and develops from 380 to 400 HP. at the turbines. This power is converted into high tension electricity, which is conducted to the Oerlikon machine shops, about 9 miles distant, by a $\frac{5}{16}$-in. copper wire. There the transmitted power is reconverted into low tension electricity and from that into mechanical power.

The second canal, on the same side, further down stream, will develop 220 HP. from 36 ft. fall, which is not yet utilized.

A third canal on the right side of the Glatt runs to the turbine house near the Glattfelden railway station, where 70 HP. are generated. This power is conveyed by a $\frac{5}{16}$-in. copper wire to the chief place of the district, Bulach. From here the glassworks, a saw mill and flour mill are furnished with power, and 250 electric lights are fed from a central station. Accumulators are used in the latter place to aid the dynamos if necessary.

The plant was constructed by the Oerlikon Machine Works. Two small turbines especially adapted for the system used are set up at the main turbine house, and make 900 revolutions per minute. The entire plant utilizes, or will utilize, nearly 700 HP. The waste water of the canals is used for irrigating purposes.

THE IRON PILLAR AT DELHI.

The famous iron pillar of Delhi stands in front of the Kutab Masjid in the Fort of Old Delhi. As described in "Indian Engineering," it is a shaft of wrought iron, 23 ft. 8 ins. high from top of capital to the bottom of its base. It is 16 ins. in diameter at the base, and 12 ins. in diameter just below the fluted bell capital with its octagonal abacus. The column itself is a round, smooth shaft, with the bottom broadened out into a slightly hollow, rough bulb, 29 ins. in diameter, and 20 ins. high. This bulb rests upon nine small cubical projections imbedded into, and secured with lead to a platform of large, dressed stone carefully laid in mortar with fine joints.

The iron in the pillar has been found to contain a minute quantity of silver, though this may be accidental. An inscription in deep early northern Gupta characters is cut into the shaft, and the letters were once inlaid with silver, now removed. The language is Sanskrit, and its reading has puzzled palæographers. The latest rendering makes it record the fame of one Chandra, and as several sovereigns bore that name its date of erection may vary from 250 to 500 A. D. The form of the capital points to the earlier date. The often published statement that this col-

WEATHER REPORTS OF VARIOUS AMERICAN CITIES FOR THE MONTH OF JANUARY, 1892.
[Furnished to Engineering News by the Department of Agriculture.]

	Station.	Temperature. (Deg. Fah.)				Wind.			Precipitation—(Rain and melted snow)—inches.		
		Average	Max.	Min.	Range.	Velocity in miles per hour. Average	Max	Direction at time of max. velocity.	Total.	Heaviest in 24 hours.	No. of rainy days.
Northern Cities.	Northfield, Vt.	16.5	49	—16	65	8.3	40	N	3.21	0.80	14
	Portland, Me.	23.6	50	2	48	9.0	44	SE	4.22	1.14	14
	New York City	30.3	62	8	54	12.9	40	NW	5.61	1.74	12
	Pittsburg, Pa.	28.1	60	2	58	6.7	26	NW	3.29	1.32	13
	Chicago, Ill.	19.5	55	—5	60	19.5	60	NW	1.90	0.57	10
	Omaha, Neb.	18.2	57	—26	83	7.7	32	NW	0.42	0.17	5
	St. Paul, Minn.	10.0	44	—25	69	6.7	28	NW	0.02	0.02	1
	Duluth, Minn.	8.1	50	—29	79	6.9	28	NW	0.48	0.24	6
	Bismarck, N. Dak.	7.4	44	—34	78	9.6	42	NW	0.29	0.12	7
	Average	18.0	52.3	—13.7	66.0	9.7	38.8		2.17	0.68	9
Southern Cities.	Washington City	31.6	62	4	58	7.9	36	NW	5.84	1.22	12
	Louisville, Ky.	29.2	60	4	56	8.8	35	W	1.46	0.60	10
	St. Louis, Mo.	25.9	60	—1	61	13.4	43	NW	1.52	0.76	8
	Savannah, Ga.	47.6	72	28	44	8.6	32	W	2.49	0.69	11
	Leavenworth, Kan.	23.9	57	—20	77	8.1	34	N	1.93	1.04	8
	Jacksonville, Fla.	53.0	77	32	45	9.1	34	SW	3.30	1.50	8
	Chattanooga, Tenn.	37.0	66	12	54	6.7	32	SE	7.39	1.94	13
	New Orleans, La.	49.0	77	26	51	8.5	32	SW	5.87	2.80	9
	Memphis, Tenn.	36.0	66	12	54	7.8	40	SE	3.66	1.69	8
	Palestine, Tex.	44.7	74	14	60	6.7	28	NW	3.93	1.40	9
	Average	37.8	67.1	11.1	56.0	8.6	34.6		3.75	1.31	9
Western Cities.	Helena, Mont.	21.2	52	—13	65	6.5	42	SW	1.02	0.28	12
	Port Angeles, Wash.	38.8	60	28	32	4.5	27	SW	4.64	2.46	15
	San Francisco, Cal.	51.7	66	40	26	4.5	31	SW	2.42	1.66	8
	Salt Lake City, Utah	25.8	45	2	43	3.3	24	NW	1.61	0.45	15
	Denver, Colo.	25 8	64	—7	71	6.3	36	NW	0.40	0.18	8
	Yuma, Ariz.	56.7	77	32	45	7.3	29	NW	1.85	0.96	4
	Santa Fé, N. Mex.	29.0	57	1	56	6.4	32	S	1.34	1.22	5
	Average	35.6	60.1	11.9	48.3	5.5	32.0		1.90	0.94	10

umn is 50 or 60 ft. long, with two-thirds of its length buried in the ground, proves to be false.

A PNEUMATIC RAPID TRANSIT PROJECT.

A somewhat novel scheme of fast traveling is being considered by a newly formed company at Hamburg, according to a technical report published in the "Zeitschrift fur Transportwesen und Strassenbau." The company is contemplating the construction of an experimental line of 15 miles in length, from Hamburg to Buchen, which distance is to be traversed in 11 minutes at a rate of 68 miles per hour. Our German contemporary does not describe the track or conduit to be used, but from the following we infer that is to consist of a circular tube. A Mannesmann steel cylinder of 6½ ft. long and 3.28 ft. in diameter is to serve as a vehicle, and is designed to receive three passengers. As soon as the travelers are "entubed," the cylinder will be closed and its very limited interior space filled with pure air from a separate reservoir. Then the vehicle will start in the same way as packages are shipped at present by the pneumatic post in Germany. The maximum speed will be gradually attained. It is asserted that, notwithstanding the great velocity of the car, its motion will be a very easy one. Each vehicle is to be provided with an incandescent light. The passenger will be permitted to carry hand baggage, but will not be allowed to smoke under any circumstances(!).

Proposals for rolling stock for Chilean railways are to be received by the State Railway Department, at Santiago, Chile, up to March 5, according to an English railway paper. The proposals are for 300 box cars, 150 cattle cars and 72 sets of wheels and axles for passenger cars.

The boiler plant for the World's Columbian Exposition is now being advertised for. Proposals for furnishing and erecting the boilers, fixtures and appurtenances will be received until March 8 by Mr. D. H. Burnham, Chief of Construction, Rookery Building, Chicago, Ill.

Steel ties are to be laid on the four-track line of the New York Central & Hudson River R. R. from the Grand Central Station, New York, to Mott Haven. The ties will be of the Hartford type, slightly different from the Hartford ties which have been in service on this road since November, 1889, at Garrison's, N. Y.

Prizes for the best essays on "Good Roads," to the amount of $10,000, are offered by Col. Albert A. Pope, President of the Pope Mfg. Co. The prizes are to be paid in bicycles. Col. Pope has already shown his enthusiastic interest in the improvement of common highways, by founding a department of Road Construction in the Mass. Institute of Technology.

The Malleco railway viaduct, in southern Chile, is described in the "Engineering Review," of London. It is 1,140 ft. long in five spans of 228 ft. each, and is supported by masonry abutments and four iron piers. The two end piers are each 143 ft. high from the top of masonry to the bottom of the bridge, and the two central piers are 222 ft. and 248 ft. high respectively. This bridge was built by the Creusot Works, of France.

The use of coal tar for water-proofing masonry is recommended by a French technical journal. For surfaces exposed to the air it is advised to apply from one to three coats boiling hot. Its durability is increased by adding a small proportion of india rubber dissolved in benzine. If the color of the coating is objectionable it may be dusted with plaster of paris before drying. Where surfaces are to be covered with earth a single coating of tar made thick by blazing is preferable. A small quantity, two or three gallons, is brought to a boiling temperature and lit at the surface. It is allowed to blaze and kept constantly stirred at the same time until the volume is considerably reduced and it becomes pasty on cooling. The product is spread as rapidly as possible with a large flat brush, which is dipped often to prevent cooling. A single coat applied in this manner adheres firmly to even the smoothest surface.

The Krupp Works at Essen, according to a recent number of "Glaser's Annalen fuer Gewerbe und Bauwesen," now contain 2,542 furnaces of various kinds, 439 boilers, 82 steam hammers with hammer weights from 220 to 110,000 lbs., 21 roll trains, 450 steam engines of 2 to 100 HP., and 1,622 different machines. The shops are brought into communication with each other by 2,730 miles of standard gage tracks with 14 tank locomotives and 542 cars, and by 1,812 miles of narrow gage track with 14 locomotives and 450 cars. Besides this, 50 miles of telegraph and 87 miles of telephone lines are being used. The works consume daily an average of 1,656 tons coal and coke, 812,000 cu. ft. of water, and 988 M ft. of illuminating gas daily. The plan of the works resembles that of a good sized manufacturing town; the Krupp belt railway encircles the works and numberless tracks traverse them. More than 24,000 guns have been delivered by the works, in which over 20,000 workingmen find steady employment. The administration lies in the hands of a board of engineers, business men and legal advisers.

CONSTRUCTION NEWS.

RAILWAYS.

East of Chicago.—Existing Roads.

ADIRONDACK & ST. LAWRENCE.—Work is being rapidly pushed all along this line between Poland and Malone, N. Y. Only nine miles remain to be put under construction.

FINDLAY BELT.—The grading has been completed on the 10-mile belt line railway at Findlay, O., and tracklaying is now in progress.

CATSKILL MT. INCLINE.—About 400 men are now at work on the incline railway from Palenville, N. Y., to near the Catskill Mt. House. An electric railway is to be built from the terminus of the incline to the Hotel Kaaterskill and to Hunter.

LONG ISLAND.—Contracts for building a portion of the New York Bay Extension R. R. will be let on March 1. About 5 miles have been located. There will be two short iron bridges on the line.

LEHIGH VALLEY.—A press dispatch says: The leasing of the Lehigh Valley by the Reading is likely to hasten the construction of the latter's projected Philadelphia and Easton R. R. from New Hope to Easton, Pa. Surveys have been made and a portion of the right of way secured. The most serious difficulty heretofore was to secure terminal facilities at Easton, but as either the Lehigh Valley or Jersey Central can now be used, that difficulty is removed and work will probably be begun this spring. The Reading's New Hope extension has been profitable, and the new line would form the shortest route between Philadelphia and Easton.

Projects and Surveys.

MOONEY LATERAL.—This company has been organized with a capital stock of $10,000 to build a railway one-half mile long to connect the Cleveland, Cincinnati, Chicago & St. Louis R. R. with tanneries at Columbus, Ind.

ALBANY TERMINALS.—The New York Central & Hudson River R. R., Co. has agreed to lease the proposed road from the river front at Albany, N. Y., to a point near the Tivoli Lake Reservoir as soon as it is completed.

NEW YORK & MIDDLE COAL FIELD.—A railway company by this name has been chartered in Pennsylvania by Chas. Hartshorne, Marion, Pa.; Elisha P. Wilbur, South Bethlehem, Pa.; Effingham B. Morris, Philadelphia, Pa., and others.

EASTERN CENTRAL.—It is stated that Ch. Engr. E. B. Shifley, of Bucyrus, O., will soon begin the survey for the eastern portion of this railway. The line is projected to run from Bucyrus to Bowerstown, O.

Southern.—Existing Roads.

GEORGIA, CAROLINA & NORTHERN.—This road has been completed to within two miles of Atlanta, Ga., and 21 miles west of its terminus on Jan. 1, 1892. The road will probably be opened for traffic to Atlanta by March 15.

BUTTERS LUMBER CO.—This company is building a short railway near Hub, N. C.

BALTIMORE & OHIO.—A branch is to be built from Sheperdstown, W. Va., to stone quarries, about 10 miles. Knott & Uhl, who own the quarries, will do the grading, and the Baltimore & Ohio R. R. Co. will lay the rails and operate the road.

JACKSONVILLE & MAYPORT.—The contract to build this railway from Jacksonville to Mayport, Fla., 25 or 30 miles, has been let to Horace Scott, of Louisville, Ky., and John D. Lyle, of Columbus, Ind. Work will begin at once.

WESTERN MARYLAND.—With the exception of the bridges this line from Williamsport, Md., to Cherry Run, W. Va., 14.3 miles, is practically ready for the track. The superstructure of the five span bridges across Cherry Run remains to be erected and one span of the bridge over the Conocoheague River is yet uncompleted.

BIRMINGHAM & JONES VALLEY.—Contracts will soon be let for grading this 65-mile line from Birmingham to Gadsden, Ala. C. O. Lagerfelt, Birmingham, Ala., Ch. Engr.

Projects and Surveys.

ROME BELT.—A company is being organized to build the proposed belt railway at Rome, Ga. T. F. Howell is at the head of the enterprise.

DUCKTOWN & CLEVELAND.—The Ducktown Sulphur, Copper & Iron Co. contemplates the construction of a railway from Ducktown to Cleveland, Tenn.

OCALA, ALTOONA, DELAND & NEW SMYRNA.—Work, it is stated, will begin in the early spring on this proposed railway from Ocala to New Smyrna, Fla. F. J. Hinson, Astor, Fla., is one of the incorporators.

CURRABELLE, TALLAHASSEE & GEORGIA.—Financial arrangements are reported completed for the construction of this proposed railway from Tallahassee, Fla., to Thomasville, Ga.

OXFORD & COAST LINE.—The contract for building this proposed railway from Oxford, N. C., east to Wilson, N. C., or some other point on the Wilmington & Weldon R. R., is reported let to J. T. Pruden.

NORFOLK, WILMINGTON & CHARLESTON.—The officers of this company, which proposes to build a railway from Norfolk, Va., to Charleston, S. C., with a branch to Columbia, S. C., are: Pres., John C. McNaughton, 228 Dock St., Philadelphia, Pa.; Treas., R. Duncan Harris; Sec., Carroll Forster; Gen. Man., C. H. McKibben.

MINERAL.—This company has been chartered in Virginia to build a railway from Quantico to Danville, Va., H. A. E. C. von Schon, Fredericksburg, Va., is interested.

MOBILE & DAUPHIN ISLAND.—Surveys are in progress under the direction of T. W. Nicol, of Mobile, Ala., for this proposed railway from Mobile, Ala., to Dauphin Island.

LOCKHART SHOALS RY. CO.—This company will be organized to build the proposed railway from Jonesville to Lockhart Shoals, S. C., 16 miles. The towns of Jonesville and Lockhart Shoals have each voted $20,000 in each of the roads. It is stated that surveys will be made at once and steps taken to begin the construction of the road.

SOUTHERN LUMBERING MFG. & R. R. CO.—Grading is rapidly progressing on this company's railway from Tallapoosa, Ga., to timber lands 16 miles south of that place.

VIRGINIA.—The following companies have applied to the Virginia Legislature for charters: Portsmouth, Smithfield & Western Ry. Co.; Portsmouth to Richmond, Va.; incorporators, W. H. Stewart, Portsmouth, Va.; M. W. Mason, Norfolk, Va.; J. D. Magruder, Surry, Va., and others.—Virginia Mineral Belt R. R. Co.; Danville, via Fredericksburg, to deep water on Potomac River; H. A. E. C. von Schon, Fredericksburg.—East Hampton Development Co.; to build a railway and bridge across Hampton River.—Lynchburg, Keysville & Atlantic Ry. Co.; to build a railway in Campbell and Charlotte counties; incorporators, John W. Craddock, W. D. Adams and others.—Berryville & West Virginia Ry. Co.—Mattoway, Keysville & Western Ry. Co.—Harrisonburg & Bridgewater Ry. Co.

ROANOKE & NEW CASTLE RY. & MINING CO.—The bill chartering this company has been signed by the Governor of Virginia and is now a law. The company proposes to build a railway from Roanoke, Va., to the Tennessee River. Among the incorporators are: J. T. Engleby, Salem, Va.; R. H. Woodrum and others.

Northwest.—Existing Roads.

DULUTH, PIERRE & BLACK HILLS.—In a recent interview Gen. Man. Jas. A. Ward said: Everything is now ready for completing the road and work will begin in April. About 75 miles of the grading have been completed, leaving 50 miles more to be graded between Aberdeen and Pierre, S. Dak. The entire grading will be completed by June 15. The ties and rails have all been purchased, and tracklaying will be commenced as soon as the grading is completed. As soon as the line is completed to Pierre steps will be taken to extend it west to the Black Hills.

DULUTH, MESABI & NORTHERN—Contracts are reported let for building large ore docks at Duluth, Minn., for this road. The docks will have a shipping capacity of 1,000,000 tons.

CHICAGO, BURLINGTON & QUINCY.—This company announces that its line from Burlington to Council Bluffs, Ia., will be double tracked this year.

BURLINGTON, CEDAR RAPIDS & NORTHERN.—Surveys have been made for a line from Manley to Forest City, Ia., about 25 miles.—It is reported that a branch will be built from Rockford to Mason City, Ia.

GREAT NORTHERN.—This company is reported to be considering the construction of a branch from St. Cloud to Little Falls, Minn., about 30 miles.

Projects and Surveys.

MARINETTE & WESTERN.—The directors of this company will soon examine the recently completed preliminary survey for its line with a view to commencing construction.

BAYFIELD & NORTHWESTERN.—Chartered in Wisconsin to build a railway from Bayfield to a point in Douglas Co. Among the incorporators are R. D. Pike, Wm. Knight, A. G. Russell and others.

GULF, KANSAS & DAKOTA.—Chartered in Kansas to build and operate a railway through Texas, Indian Territory, Kansas, Nebraska, North Dakota and South Dakota. Among the incorporators are: J. L. King and D. S. Pipes, of Topeka, Kan., where the principal office will be located, and Geo. T. Alford, Dallas, Tex., and W. G. Veal, Fort Worth, Tex.

LITTLE WABASH.—It is stated that this company will, on April 25, issue $1,500,000 of bonds to be used in building and equipping its line from Effingham to Carmel, Ill.

JULIET, DE KALB & NORTHERN.—The officers of this company, whose incorporation was noted in our issue of Feb. 13, are as follows: Pres., O. L. Ellwood, De Kalb, Ill.; V.-P., J. B. Speer, Joliet, Ill.; Treas., Edgar L. Henning, Plano, Ill., Secy., E. W. Flaxon, Plano.

Southwest.—Existing Roads.

CHICAGO, ROCK ISLAND & PACIFIC.—The engineers of this company have reached Henrietta, Tex., on the line south from Minco, Ind. Ter.

TEXAS TRUNK.—This company will construct a short line at Dallas, Tex., to connect its lines with those of the Houston & Texas Central R. R.

GALVESTON & WESTERN.—In addition to changing this line to standard gage, it will be extended two or three miles west of its present terminus at Lafitte, Tex.

HOUSTON & TEXAS CENTRAL.—Surveys are reported in progress for an extension from Roberts to Greenville, Tex. It is stated that grading will begin by June 1, and that the line will be completed by August.

MISSOURI, KANSAS & TEXAS.—Work is in progress upon the extension of the Dallas-Hillsboro branch into the city of Dallas, Tex.

KANSAS CITY SUBURBAN BELT.—Work on the extension of this line west from its present terminus to the Kansas line will begin at once.

CLEVELAND, ST. LOUIS & KANSAS CITY.—A press dispatch says that a corps of engineers have begun the survey of this line from Hamburg to Boonville, Mo.

AUSTIN & NORTHWESTERN.—A large force of men and 150 teams are now at work on the line from Fairland to Llano, Tex., 29 miles, and this force will be largely increased. Eleven miles of the grading have been completed, and work is making good progress upon the masonry for the bridge across the Colorado River. It is expected to have the entire line in operation by April 1.

PAN AMERICAN.—This road has been located from Victoria, Tex., south 78 miles and 10 miles have been graded. The total distance from Victoria to Browns ville, Tex., is 240 miles. The work is very light, the only cutting or filling of any consequence being the 20-mile section from Victoria to the San Antonio River. Wm. Davis, Victoria, Tex., is in charge of construction.

Projects and Surveys.

KANSAS CITY & NEW ORLEANS.—This company proposes to build a railway from the Choctaw coal fields across Bowie and Cass counties to Collins Bluff, Ark., 97 miles. About 42 miles of the route consists of a narrow gage line which is to be acquired and made standard gage. The contract for a portion of the work will be let soon. The officers are: Pres., W. A. Disborough; Ch. Engr., Hugh Stewart, and Secy., M. M. Hannah. The

present headquarters of the company are at 314 Commerce St., Dallas, Tex., but they will be changed to Dalby Springs, Ark., on April 1.

VELASCO & SURFSIDE.—Chartered in Texas to build a railway by this name. Among the incorporators are W. M. Lee, G. W. Angle, Lewis R. Bryan and others.

Rocky Mt. and Pacific.—Existing Roads.

OREGON PACIFIC.—A press dispatch from Albany, Ore., says: A construction train and a force of men were sent to the front on the Oregon Pacific R. R. to-day to put the road in good repair to the eastern terminus of the track preparatory to resumption of the work of construction, which it is announced will be pushed forward to Eastern Oregon as soon as the spring opens.

DENVER, APEX & WESTERN.—The latest report in regard to this enterprise is that it is backed by D. H. Moffat, the former President of the Denver & Rio Grande R. R., and will form a link in a new transcontinental line. The new transcontinental line will, it is claimed, run over the right of way of the Denver, Apex & Western to the Atlantic & Pacific tunnel, and through the divide by means of this, then run down through Keystone to Dillon; thence through the valley of the Blue to Grand Junction, there connecting with the Rio Grande Western, and to Ogden or the ocean, as may be decided.

GREAT NORTHERN.—It is stated that surveys are in progress for a branch of the Pacific extension to Spokane, Wash.

PUGET SOUND & PACIFIC OCEAN.—Work has begun on the two-mile branch west to timber lands owned by the Port Blakeley Mill Co. It will take about two weeks to complete this branch, and it is stated that work will then begin on the extension of the main line to a connection with the Northern Pacific R. R.

NORTHERN PACIFIC.—About 500 men are now at work on the line from Chehalis to South Bend, Wash., 56 miles, and the force is to be increased to 2,000. Between Chehalis and Pe Ell, 20 miles, the track was laid last year and is now being ballasted. West of Pe Ell the grading is completed a considerable distance beyond the Chehalis River. The right of way is cleared up Rock Creek to the summit of the mountains and grading is in progress. The work is very heavy in some places; maximum grade 95 ft. per mile and maximum curve 12°.

GREAT NORTHERN.—This company has filed a map showing the location of its Pacific extension across Washington. According to the map, the line will run from near the mouth of the Snohomish River. It follows the south bank of the Snohomish River a few miles, then, leaving the river, it again touches its bank at a point two miles south of Snohomish City, about three-fourths of a mile north of Cathcart, on the Seattle, Lake Shore & Eastern R. R. The line then runs directly east, following the north fork of the Skykomish River and going through the mountains at Stevens' Pass. From Stevens' Pass the road runs east by south, crossing the Wenatchee at Lake Klakim, thence southeast to Wenatchee, crossing the Columbia close to Wenatchee City. From Wenatchee the course is southeast for a distance of 10 miles, almost to Coulee ferry, and from there directly east to Crab Lake. From that point it proceeds north by east to the source of Crab Creek and thence to Chatteroy. It is said only two causes will prevent this route being followed, and they are the interference of the Interior Department and the purchase of the branch of the Seattle, Lake Shore & Eastern running from Spokane to Coulee City. Both events are said to be very unlikely to happen, and it is probable that the foregoing route will be followed.

Projects and Surveys.

ALBUQUERQUE & DURANGO.—It is stated that parties have been found who will cash the bonds of this road as soon as the surveys and reports of resources are verified. The road is projected to run from Albuquerque, N. Mex., to Durango, Colo.

BAKERSFIELD & HARTFORD.—M. O'Shaunessy, of San Luis Obispo, Cal., is Chief Engineer of this proposed 35-mile railway from Bakersfield to Port Hartord, Cal.

SEATTLE & TACOMA.—The line for the Boynton Bicycle Railway between Tacoma and Seattle, Wash., is now being located.

HELENA & CASTLE.—It is stated that W. A. Havens has been given a contract to survey the definite route of a railway from Helena, Mont., to Castle, 115 miles distant. The contract is with the Helena citizens' committee, representing the subscribers to the fund of $200,000 by citizens of Helena and Castle, to be given the corporation building the road. Three separate syndicates are reported to have agreed to float the bonds, providing the survey demonstrates that the line can be built for $2,250,000. Mr. Havens thinks that the line can be built for less than $2,000,000.

PORT ANGELES SOUTHERN.—C. E. Mallette, of Port Angeles, Wash., Supt., is reported as saying that the right of way will be cleared and that construction will be begun on this line from Port Angeles to Junction City, Wash., 35 miles, within one month.

NICOLA VALLEY.—The preliminary survey for this proposed railway from Spence's Station, B. C., on the Canadian Pacific Ry., to Nicola Lake, 40 miles, has been completed. A very favorable line is stated to have been secured.

FLORENCE, CRIPPLE CREEK & STATE LINE.—Chartered in Colorado to build a line of railway by this name. Among the incorporators are Thos. Robinson, Ike. Canfield, Jas. Collins and others.

Foreign.

MEXICAN NORTHERN PACIFIC.—It is stated that the contract for building this proposed railway in Northern Mexico has been signed by an English syndicate.

CHIHUAHUA EASTERN.—A railway is projected from Sierra Mojada, Mex., to the Laguna de Jaco salt deposits, a distance of 60 miles. Gen. Man., J. H. Dickey.

ELECTRIC RAILWAYS.

MANCHESTER, N. H.—The street railway company will build an electric line to Lake Massabesic this spring.

SARATOGA, N. Y.—The contract for track work on the Saratoga Union Electric Ry. Co.'s extension has been let to J. D. Murray, of New York.

NEWARK, N. J.—The roadbed of the electric railway to Jersey City is being laid. The contractors are B. M. & J. F. Shanley, of Newark, and A. Sandford, of Newark, has the contract for poles and wires. Ordinary tee rails are used.

ALEXANDRIA, VA.—The Alexandria & Fairfax Ry. Co. is having surveys made for the line to Mt. Vernon, a distance of 10 miles. It is proposed to use storage battery cars. Secy., L. W. Spear.

LINCOLN, NEB.—The Lincoln Street Ry. Co. has been organized by T. W. Little, C. C. Upham, and C. F. Ernest, to build electric railways; $2,000,000.

ELEVATED RAILWAY.

CHICAGO, ILL.—It is stated that the franchise and uncompleted structure of the Lake St. elevated road have been sold to Eastern parties for $2,400,000, and that work will be resumed shortly and the road be completed by the end of the year. There is about a mile of structure built and track laid, foundations have been laid for 1½ miles, and right of way has been secured for 6 or 8 miles.

HIGHWAYS.

ALABAMA.—The contract for common labor and teams for the grading of 50 miles of roads on the Chattanooga and Chickamauga National Park has been awarded to J. C. Cross and George O Tenney, of New Decatur, Ala. It is expected that the work will occupy 3 years and will require 150 men and 40 teams.

ILLINOIS.—The Hoyt Macadam Gravel Road Co., of Chicago, has been incorporated by Fred. J. Hoyt, Wm. H. Chandler and W. G. Doolittle.

BRIDGES, TUNNELS AND CANALS.

CUMBERLAND, MD.—The West Virginia Central & Pittsburg R. R. Co. contemplates the construction of a substantial iron viaduct to replace the wooden one now in use between the station and the bridge over the Potomac below the dam.

HAMPTON, VA.—The East Hampton Development Co. has obtained authority from the legislature to construct a bridge across the Hampton River in Elizabeth City Co.

KNOXVILLE, TENN.—The Manufacturing Construction Co. will be incorporated, with a capital stock of $255,000, for the construction of bridges and structural work of kinds.

GALVESTON, TEX.—The Commissioners Court of Galveston County has ordered an issuance of $175,000 of bonds for the purpose of providing funds to construct a bridge connecting the island with the mainland. For particulars address W. B. Lockhart, County Judge.

LLANO, TEX.—The Commissioners' Court of Llano Co. has instructed W. S. Maxwell to advertise for bids for the construction of an iron bridge across the Llano River.

WATER-WORKS.

New England.

QUINCY, MASS.—The council has adopted orders for a special election on March 28 to vote on the purchase of the works of the Quincy Water Co.

SHEFFIELD, MASS.—It is reported that a company is willing to build works provided a guarantee of 4½% upon the investment is secured.

ORANGE, MASS.—It is reported that the legislature has granted authority for the organization of a water company which may pump its supply from North Pond to a reservoir on Walnut Hill.

UXBRIDGE, MASS.—The residents of the north and east parts of the town will try to secure orders for extensions of the mains at the coming March meeting.

WALTHAM, MASS.—The last report of the water department states that the commissioners are considering the advisability of covering the reservoir and filter basin and that they recommend a new force main with a daily capacity of 5,000,000 gallons. The estimated cost of the force main is $16,000.

Middle.

AUBURN, N. Y.—A bill is before the legislature authorizing the city to vote on municipal ownership. In case the people vote for such ownership the city is authorized to issue bonds to the amount of $500,000 with which to buy the present plant or to build new works with a supply from Owasco Lake, the present source.

CORNWALL, N. Y.—A recent fire at this place leads the "Local" to advocate the building of works. It thinks that a gravity supply could be introduced.

GLENS FALLS, N. Y.—A citizens' committee has reported to the village trustees recommending a dam and reservoir on Clendon Brook, and a vote on raising money for the same by taxation.

ILION, N. Y.—Bids for constructing works are wanted until March 22, as set forth in detail in our advertising columns.

LOCKPORT, N. Y.—The bill authorizing the city to contract for water from the proposed canal from the Niagara River has passed the Senate and gone to the Governor.

MONTGOMERY, N. Y.—The water-works project has become indefinite, at least for the time.

NEW YORK CITY.—Authority to expend $500,000 for additional pumping machinery and mains has been granted.

ROCHESTER, N. Y.—The Senate has passed a bill authorizing the issuance of bonds for an additional supply.

SYRACUSE, N. Y.—The city will issue water bonds to the amount of $500,000 for the new works.

JERSEY CITY, N. J.—Authority to issue $5,000,000 of bonds for a new supply has been asked.

RARITAN, N. J.—The company will extend its mains.

SHREWSBURY, N. J.—The Rumson Water Co. has been incoporated by W. E. Strong, C. Macdonald and others, residences not given; capital stock, $100,000, all of which is said to be paid in.

BRADFORD, PA.—City Engineer Dalrymple is surveying a site for a new reservoir and pipe line. It is said that East Bradford may be supplied.

PHILLIPSBURG (BEAVER CO.), PA.—The people of this place have voted by a majority of 80 to build works, according to a press dispatch.

RED LION, PA.—It is reported that Seth Minnich is successfully soliciting subscriptions with a view of forming a water company.

SHARON, PA.—The company has voted to increase its capital stock by $50,000, to meet cost of extensions.

Southern.

MACON, GA.—We are informed that a new contract, running 20 years, between the city and company, went into effect Feb. 1, and that the city will not build works as formerly proposed.

LAKE CHARLES, LA.—The people have voted a tax to pay for water for public uses. The Lake Charles Ice, Light & Water-Works Co. will build works at once under a 10-years contract. Pres., J. A. Landry.

North Central.

BOWLING GREEN, O.—The election to vote on the granting of a franchise to I. W. Newcomer, Cleveland, has been postponed by the Council, indefinitely, it appears. Works are wanted but popular feeling seems to be against the terms of the franchise.

CINCINNATI, O.—Bids will be received by the Board of Administration until March 17 for a 1,500,000-gallon horizontal compound duplex pumping engine to work against 225 lbs. hydrostatic pressure. Bids must include an allowance for three old pumps at the Eighth St. station. The new pump will be located at the new Price Hill station. Bids are also wanted until March 17 for two 80 HP boilers to carry 125 lbs. pressure and to set in a 20-ft. space, leaving ample passage on each side. The contractor will remove two boilers from the Eighth St. station. In addition bids are wanted until March 22, for a 1,000 H P. plant of water tube or other type of boilers, complete, excluding grates. Separate bids are wanted for equipping the boilers with a mechanical stoker, and also for boilers with "a first class arrangement for burning oil or gas as fuel." Address Willis P. Tharp, Superintendent and Engineer.

CUMBERLAND, O.—It is reported that the Council has taken steps for the betterment of the water supply. So far as known there are no works in this place.

NAPOLEON, O.—J. B. Strawn, Salem, informs us that he has nearly completed plans, estimates and specifications for water and electric lighting plants. The plans include 7¼ miles of 12 to 4-in. mains, 70 hydrants, 52 valves, a 120,000-gallon water tower and pumping station. The two plants are estimated to cost $60,000. A vote on the building of the plants will be taken at the coming annual election.

WESTON, O.—The people have voted for works, 159 to 54. The council has voted $75 for the use of a committee in securing plans and specifications.

WILLOUGHBY, O.—At a special election the people voted 192 to 31 for works and 147 to 68 for municipal ownership. It is expected that the works will be in operation this summer.

HAMMOND, IND.—The people have voted, 458 to 16, to issue $25,000 of bonds for works.

MARTINSVILLE, IND.—It is said that works could be built for $20,000.

JACKSON, MICH.—The Board of Public Works has called the attention of the Council to the imperative need of an increased supply.

CLAYTON, ILL.—Works have been talked of since a recent fire.

OTTAWA, ILL.—George C. Morgan, Chicago, addressed the City Council last week regarding new works. The present plant is owned by a company.

WAUKEGAN, ILL.—The Waukegan Water-Works Co. has been incorporated by C. E. Loss, Homer Cook and Chas. Whitney; capital stock, $100,000. The town built works in 1874.

Northwestern.

ST. CLOUD, MINN.—A press dispatch states that Col. J. T. Fanning, Minneapolis, has reported that the works are inadequate.

SOUTH ST. PAUL, MINN.—The council has accepted the city engineer's plans for works estimated to cost about $70,000, and including an artesian well, pumping station and machinery, stand-pipe, ten miles of mains, and other appurtenances. A special election will probably be called to vote bonds, the election which voted bonds a year ago having been illegal.

GREELEY, NEB.—The proposed town works are estimated to cost $16,000, and it is expected that they will be built as soon as the ground thaws.

NEBRASKA CITY, NEB.—The works were sold Feb. 14, at a "special master commissioner's sale," to E. Ellery Anderson, New York City, for $151,000. Immediately after the sale steps were taken to incorporate a new company with a capital stock of $300,000, said to be paid up. Mr. Anderson, T. L. Watson, Bridgeport, Conn., Wm. L. Wilson and M. L. Hayward, Nebraska City, and others are the incorporators. It is stated that the capacity of the plant will soon be increased.

NIOBRARA, NEB.—It is reported that the Niobrara Mill & Water-Works Co. has decided to begin the erection of a mill building in April and to call for a special election of the town to vote $4,000 bonds for the laying of water mains and building of works. The flow of the artesian well has increased considerably.

O'NEILL, NEB.—The issuance of $15,000 of bonds for works is being discussed.

SHELDON, IA.—The Sheldon Water Supply, Electric Light, Heating and Power Co. has filed articles of incorporation: Pres., E. C. Brown; Secy. and Treas., H. W. Conant, who is also City Clerk; Gen. Man., H. W. Shepard, of the contracting firm of Hudson & Shepard, Beatrice.

GRAFTON, N. DAK.—It is reported that the city has granted T. F. McHugh a 20-years' franchise to supply the city with water and electric light. A new power-house will be erected. The city built water-works in 1886.

Southwestern.

LLANO, TEX.—It is said that the Llano Water Supply Co will issue bonds to enlarge and improve its water-works system.

McGREGOR, TEX.—The water tank containing 50,000 gallons of water burst the morning of Feb. 14. No damage was done save to the tank.

MILLS POINT, TEX.—At a citizen's meeting E. A. Wingo, T. T. McKain, W. E. Eastwood and J. B. Dodson was appointed to report on a water supply and to select a location for a reservoir.

CREEDE, COLO.—It is reported that the Creede Water & Electric Co. has been organized by parties interested in the Citizens' Water Co., Denver; capital stock, $100,000; Engr., C. P. Allen, Denver.

Pacific.

SACRAMENTO, CAL.—Another experimental artesian well has proved successful, according to report.

STOCKTON, CAL.—It is reported that the Board of Public Works has adopted plans for new pumping machinery, including a 4,320,000-gallon Corliss pumping engine.

VALLEJO, CAL.—The Board of Trustees of Vallejo have adopted the report of G. E. Grunsky on works for that city. The proposition is to build a dam on Suscol Creek, 10 miles distant, and convey the water in a 14-in. steel pipe to the city. The dam is to be of earth on a solid rock foundation, 100 ft. high and 960 ft. long, as reported. The proposed reservoir would cover an area of 24½ acres, and have a capacity of 258,500,000 gallons. An

election will be held March 12 to vote on the issuance of $350,000 of bonds.

BRIGHAM CITY, UTAH.—Surveys for the new works are being made by David James and Mr Fortier, the latter of Ogden. It is expected that the supply will be from Three Mile Creek Cañon. The city will do the work by day's labor. J. M. Sensen, H. L. Steed, Jas. Pett, W. W. Com.

ARTESIAN WELLS.

MEMPHIS, Tenn.—The Artesian Water Co. propose to put down 20 additional wells. Pres., R. C. Graves.

RANDOLPH, NEB.—A vote is proposed on the issuance of $5,000 of bonds for a well.

WAKONDA, S. DAK.—There is talk of sinking a well for fire protection.

IRRIGATION.

BEAUMONT, TEX.—Engineers from the real estate agency of Jas. H. Rochford have begun the survey of an irrigating canal from Grigsby's Bluff, on the Neches River, to Kiceland, seven miles, where it will tap Rodair Bayou. If found feasible a company will be organized and work will at once be begun on the construction of a canal designed to open up about 50,000 acres of fine prairie land to rice culture. The promoters propose to place a large engine and pump on the Neches River and raise the water to the canal.

BERTHOND, COLO.—The Handy Ditch Co. will take steps to construct storage reservoirs.

BAKERSFIELD, CAL.—The East Branch Canal Co. has been incorporated. Directors: W. R. McMurdo, J. J. Mack, E. E. Elliott, Dave Hirschfeld and J. E. Smith; capital stock, $500,000 It is proposed to build a branch of the Kern Island canal over the plains southeast of Sumner, known as the Weed Patch, the canal to be 20 ft. wide and 20 miles long.

MARYSVILLE, CAL.—The Brown's Valley Irrigation District will vote Mar. 11 on the issuance of $30,000 of bonds. Forbes & Dinsmore are attorneys for the district.

NEW COMPANIES.—The Harlem Irrigation Co., Chateau Co., Mont; E. M. Kennedy, Thomas M. Everett and others; capital stock, $250,000. East Side Irrigating Co., Hood Run, Ore.; F. M. Jackson, S. H. Cox, Hens Sage; $6,000. Sand Creek Water Co., Egin, Idaho; $10,000.

SEWERS.

BATH, ME.—Mr. W. E. McClintock, of Boston, is preparing plans for a system of sewerage. The length will be about 20 miles and the cost above $50,000.

BEVERLY, MASS.—The committee recommends that only a sewer on Cabot St., to run to the sea by a tunnel under Lothrop St., be put in this year. It is intended that this be used as the future outlet of the entire system, and the estimated cost is $10,000.

EASTHAMPTON, MASS.—Profiles and estimates for a complete system have been prepared by W. E. McClintock, of Boston. The total estimate is $96,000.

NANTUCKET, MASS.—The estimated cost of the complete system proposed is $161,276. About 10 miles of pipe will be needed, and it is intended to have the work completed by June 15. E. Bowditch is Engineer.

SOUTHBRIDGE, MASS.—The State Board of Health is of opinion that the sewage from the proposed system should not be discharged, even temporarily, into the millpond, and advises a more extended investigation.

WOONSOCKET, R. I.—Mr. Rudolph Hering, of New York, has been engaged to examine the conflicting reports of the experts and report upon the best method of sewage disposal for the city.

NEW YORK, N. Y.—Commissioner Heintz has approved plans for an outlet sewer in 134th St., from Long Island Sound to Willow Ave. It is estimated that the completion of the work will involve 8,200 cu. yds. of rock excavation, 35,000 lin. ft. of piles and 100,000 ft. of lumber. The total length, including branches, will be about two miles. There are also two smaller contracts awaiting advertisement, which includes 500 ft. of 26 by 36-in. brick sewer and 1,375 ft. of 12 to 18-in. pipe sewer.

ROANOKE, VA.—Mr. Samuel M. Gray, of Providence, R. I. has been selected as the expert engineer to decide upon the merits of the different plans proposed.

COLUMBIA, S. C.—Bids are asked until March 7 for surveying a system of sewerage for the city; the engineer selected to furnish map, profile an estimated cost of the sewer. W. J. Cathcart, City Clerk and Treasurer.

CANTON, O.—The committee has reported in favor of chemical precipitation. The cost of a complete plant is estimated at $38,000. Mr. S. M. Gray, of Providence, R. I., is Consulting Engineer.

CLEVELAND, O.—The citizens of West Cleveland have passed resolutions urging the Council to take action for a system of sewerage in that part of the city.

COLUMBUS, O.—All bids for constructing sewer in sub-sewer district M of District No. 2 have been rejected. The contract for sewers in sub-sewer district K was awarded to M. Nealon at $18,349, the lowest bid.

FINDLAY, O.—Bids are asked until March 4 for the construction of sewers. Marion G. Foster is clerk of the Common Council.

OBERLIN, O.—The Council has recommended a separate system of sewerage.

RICHMOND, IND.—The proposed south end brick sewer is estimated to cost $40,000.

TERRE HAUTE, IND.—Bids are asked until March 15 for the construction of 743 lin. ft. of 4-ft. brick sewer. Chas. H. Goodwin, City Clerk.

DETROIT, MICH.—The City Controller will sell $500,000 of sewer bonds on March 1.

ALTON, ILL.—The Council has voted to construct several sewers.

LAKE FOREST, ILL.—Bids are asked until March 7 for the construction of 3.2 miles of iron and tile pipe sewer. George Frazier, City Clerk.

OWATONNA, MINN.—Bids are asked by the City Council until March 22 for the construction of 5,550 lin. ft. of 8 to 15-in. pipe sewer. C. F. Loweth, of St. Paul, is the Engineer.

SANTE FE, N. MEX.—The City Council has accepted the plans of P. O. Gaynor, of Pueblo, Colo., for a complete system of sewerage, estimated to cost $105,000.

STREETS.

NEWARK, N. J.—The City Council has voted in favor of $500,000 of street paving bonds.

BALTIMORE, MD.—The Mayor has signed ordinances for the paving of Broadway with sheet asphalt and Eutaw St. with asphalt blocks.

LEXINGTON, KY.—The City Surveyor has prepared surveys and specifications for paving South Broadway with brick. It is the intention to pave about two miles of streets at an estimated cost of about $150,000.

LOUISVILLE, KY.—First St. is to be paved with asphalt, at a cost of $10,000.

CLEVELAND, O.—East Prospect St. is to be paved with asphalt and Fourth Ave. with brick. The Board of Control will receive bids until March 2 for grading, curbing and improving 16 streets.

COLUMBUS, O.—The City Engineer estimates the cost of improving High St. at $84,230.

DAYTON, O.—The City Auditor will sell street paving bonds aggregating $275,000, March 21.

SANDUSKY, O.—The City Engineer estimates the cost of paving Columbus Ave., from Water St. to Adams St., with asphalt, $30,000; with brick, $24,000.

SPRINGFIELD, O.—The Board of Public Affairs is considering estimates for paving with brick, aggregating nearly $115,000.

TOLEDO, O.—The lowest bids for paving Lagrange St. were as follows: William MacMahan, Medina stone with Medina curb, $14,193; same with Berea curb, $13,776; cedar block with Medina curb, $8,014; same with Berea curb, $7,598; H. C. Streicher, fire brick with Medina curb, $10,628; same with Berea curb, $10,326.

INDIANAPOLIS, IND.—The City Engineer has prepared specifications for five paving contracts, three with asphalt and two with brick.

RICHMOND, IND.—The estimated cost of the proposed paving of Main St. with vitrified brick is $50,000.

DETROIT, MICH.—The Board of Public Works desires $601,870 for paving this year.

EAST ST. LOUIS, ILL.—The City Council has voted to pave West Broadway with granite at an estimated cost of $25,000.

OTTAWA, ILL.—The City Council has voted in favor of about two miles of paving to cost $70,000.

ST. LOUIS, MO.—Bids are asked by the Board of Public Improvements until March 8 for street improvements.

GALVESTON, TEX.—The contract for paving 14 blocks with vitrified brick has been awarded to E. B. Lull, Ritchie & Co., and for paving 26 blocks with creosoted wood to J. E. Byrne, of Dallas. The bids were published last week.

ELECTRICAL.

NEW YORK, N. Y.—The Gas Commissioner has awarded contract for 16 lamps on Fifth Ave. to the East River Electric Light Co., at 50 cts. a light per night. Last year the same company received 45 cts., and this year 60 cts.

NASHVILLE, TENN.—The Cumberland Electric Light & Power Co. has acquired the electric plant, and will spend nearly $100,000 in increasing its capacity.

NAPOLEON, O.—Mr. J. B. Strawn, of Salem, has prepared plans and specifications for an electric light plant for both arc and incandescent lighting.

LAFAYETTE, IND.—The new contract with the Brush Electric Light Co. is for five years at $75 per lamp per year.

DUNDEE, MICH.—The City Council has granted a franchise to the Dundee Electric Light Co., and contracted for 16 lights at $60 each per year.

WINNIPEG, MAN.—The contract for electric street lighting has been awarded to R. Miller & Co., who have assigned it to Harper & Co. The contract is for three years, at 58 cts. per light per lamp for 100 to 120 lamps, and 54 cts. per light when 120 are burning.

NEW COMPANIES.—Water & Light Co., Nebraska City, Neb.; $600,000; E. E. Anderson, of New York; T. L. Watson, of Bridgeport, Conn.; D. P. Rolfe, of Nebraska City. Sheldon Supply Electric Light, Heating & Power Co., Sheldon, Ia.; $100,000; President, E. C. Brown; Secretary and Treasurer, H. W. Conant. Oklahoma City Light, Manufacturing, Canal & Water Power Co., Oklahoma City, Okla.; $150,000; President, W. D. B. Jones; Secretary, J. H. Bell, both of Brooklyn, N. Y. Central Electric Light & Power Co., Chicago, Ill.; $500,000; A. T. McDonald, W. Harding and W. J. Buckley.

CONTRACT PRICES.

PAVING.—Cincinnati, O.—The following bids have been received for asphalt paving, the first being that of the Warren-Scharf Asphalt Co., and the other that of J. H. Finnegan: Curbs, $1.25, $1.25 per lin. ft.; curbs, circular, $2.40, $2.25; curbs reset, 20 cts., 1 ct.; asphalt, $2.80, $2.70 per sq. yd.; gutter flagging, $1.30, $1.30 per lin. ft.; resetting curbs and gutters, 15 cts., 10 cts. per lin. ft.; repairing, 50 cts., 20 cts. per sq. yd.; broken stone, $1.80, $1 per cu. yd. The total bids are $73,848 and $71,662, and the contract was awarded the lowest bidder.

Louisville, Ky.—The contract for paving Sixth St. with vitrified brick has been awarded to Geo. W. Gosnell, at $17.50 a square.

CURBING AND SIDEWALKS.—Holyoke, Mass.—The following were the lowest bids opened by the Committee on Sidewalks: J. E. Farrell, concrete work, 45 cts. per sq. yd. for new work, and 20 cts. for recovering old walks; D. J. Landers, brick sidewalks, 48 cts. per sq. yd.; John Frawley, of Wendell, curbing, 54 cts. per lin. ft. The first two contracts were awarded.

CEMENT SIDEWALKS.—New Orleans, La.—The only bid received for paving Congo Square with cement was as follows: Chas. W. Drown, cement work, $1.38 per sq. yd.; resetting curb and gutter bottom, 25 cts. per lin ft.; iron bridges, 3 cts. per lb.; 6-in. vitrified pipe, 3 cts. per ft.

CEMENT.—Detroit, Mich.—The contract for cement has been awarded by the Board of Public Works to W. A. Bourke & Co., at a net price of 47 cts. per bbl., this being the lowest bid. About 50,000 bbls. will be used the coming year.

CURBSTONE.—Brookline, Mass.—The Park Commissioners have awarded the contract for 11,000 ft. of curbstone for the Muddy River improvement to A. A. Libby & Co., of Boston, Mass., at 62 cts. per ft. for straight, and $1.15 for curved stones.

MISCELLANEOUS.

DREDGING.—Milwaukee, Wis.—Bids are asked by Maj. James F. Gregory, U. S. Engineer Office, until March 16 for dredging about 60,000 cu. yds. at Waukegan harbor.

LIGHTHOUSE SUPPLIES.—Portland, Me.—Bids will be received until March 21 for furnishing mooring stones, buoy irons, shackles and spare keys. Address Frank Wildes, Commander, U. S. N., Lighthouse Inspector.

VALVES.—Detroit, Mich.—Bids are asked by Col. O. M. Poe, U. S. Engineer Office, until March 4, for furnishing 12 valve frames and 14 valves for the 800-ft. lock at St. Mary's Falls Canal, Mich.

STREET LANTERNS.—Washington, D. C.—Bids are asked until March 8 for furnishing 500 street lanterns. J. W. Douglass is one of the commissioners.

BOILERS.—Chicago, Ill.—Bids are asked until March 8 for furnishing and erecting complete at Jackson Park, boilers, fixtures and appurtenances to supply steam for the World's Columbian Exposition. Address D. H. Burnham, Chief of Construction, Rookery Building.

TERRA COTTA ROOF AND FLOOR TILES.—Washington, D. C.—Bids are asked until March 5 for furnishing and delivering hollow terra cotta roof and floor tiles for the building for Library of Congress. Bernard R. Green, Supt. and Engr.

ELEVATOR.—Washington, D. C.—Bids are asked until March 9 for furnishing and erecting complete the hydraulic passenger elevator, including pump tanks, piping, cars, etc., for the United States building at Wichita, Kan. W. J. Edbrooke, Supervising Architect, Treasury Department.

DRAIN PUMP.—New Orleans, La.—The following bids have been opened for the erection of a new drain pump: Joseph Menge, $54,100; J. L. O'Connor, $89,000; B. C. Howell, of New York, $110,168; Henry R. Worthington, of New York, $143,250.

PAVING MATERIALS.—Louisville, Ky.—Bids will be received at the Mayor's office until March 5 for furnishing vitrified paving brick or blocks for 28,000 sq. yds.; also for about 6,000 tons of granite paving blocks.

MANUFACTURING AND TECHNICAL.

LOCOMOTIVES.—The Brooks Locomotive Works, Dunkirk, N. Y., have orders for 8 ten-wheel engines for the Toledo & Ohio Central, and 2 twelve-wheel engines for the Iron Range & Huron. The Pennsylvania will build 25 freight engines at the Columbus shops, 7 passenger and 9 freight engines at Altoona, and 10 passenger engines at Fort Wayne.

CARS.—The Pullman Palace Car Co., Chicago, Ill., is building 5 passenger cars and 3 parlor cars for the Columbus, Hocking Valley & Toledo. The St. Charles Car Co., St. Charles, Mo., has orders for 10 passenger and 5 baggage cars for the St. Louis & San Francisco. The Michigan Car Co., of Detroit, Mich., has an order for 1,000 box cars for the New York Central. The Eastern Car Co. has been incorporated by Goodwin Stoddard, W. D. Bishop and H. T. Shelton, of Bridgeport, Conn.; capital stock, $20,000. The Joliet Equipment Co., of East St. Louis, Ill., has been incorporated by Henry O'Hara, C. W. Cowles and John W. Mans, with a capital stock of $1,000,000. The Lafayette Car Works, Lafayette, Ind., will be sold at public auction, March 30, by W. P. Fishback, Master in Chancery.

THE CONSOLIDATED CAR HEATING CO. has purchased a tract of land near the north end of the city of Albany and let contracts for the erection of a new four-story factory and warehouse. The factory will be largely equipped with new machinery and special tools designed to reduce to a minimum the cost of manufacture. The top floor of the building will be devoted to testing and experimental work; all finished work will be carefully tested here before leaving the factory. The company will remove to its new quarters about June 1.

TOLEDO BRIDGE CO.—In our issue of Feb. 20 we ment oned Mr. H. O. Duerr as engineer of this company. Mr. C. L. Gates and Mr. M. J. Riggs, engineers of the Smith Bridge Co., will also be retained as engineers of the new concern.

KING BRIDGE CO.—At a meeting of the Board of Directors of the King Iron Bridge & Mfg. Co., of Cleveland, O., it was decided to increase the capital stock to $1,000,000, and to shorten the name of the corporation to the King Bridge Co.

THE BERLIN IRON BRIDGE CO., of East Berlin, Conn., has a contract from the True Blue Marble Co., Rutland, Vt., to replace the mill lately destroyed by fire with a building 254 x 80 ft., composed entirely of iron and marble, the side walls being of iron and marble and the roof of corrugated iron. All the framework inside for carrying the gang saws, shafting, etc., will be of iron.

NEW COMPANIES.—Marsh Movable Jetty Co., Cairo, Ill., James H. Rees, T. W. Shields, Grant Marsh and O. L. Garrison: $1,000,000. Tar Spring Asphalt Co., Los Angeles, Cal.; Victor Pouet, Andrew Mullen and J. T. Conroy; $200,000. Western Disk Drill Co., Oakley, Kan., K. E. Wilcockson, of Oakley; Burton Smith and R. B Snell, of Monument; $10,000. Manitoba Stone & Asphalt Paving Co., Winnipeg, Man.; C. A. Stark and E. E. Twiss.

CURRENT PRICE LIST.

RAILS.—New York: $30 at eastern mills; old rails, $20 to $20.50 for iron and $14 to $15 for steel; girder rails, $40. Pittsburg: $30; old rails, $22 to $22.50 for iron and $16.75 to $17.50 for steel. Chicago: $31.50 to $32; old rails, $21.75 for iron and $14 for steel.

TRACK MATERIALS.—New York: steel angle bars, 1.65 to 1.7 cts.; spikes, 1.95 to 2.05 cts.; track bolts, 2.6 to 2.75 cts., with square and hexagonal nuts. Pittsburg: splice bars, 1.7 to 1.8 cts. for iron or steel; iron or steel spikes, 2.15 cts.; iron track bolts, 2.65 cts. with square and 2.75 cts. with hexagon nuts. Chicago: splice bars, 1.8 to 1.85 cts. for iron and steel; spikes, 2.15 to 2.25 cts.; track bolts, 2.65 to 2.8 cts. with hexagon nuts.

PIPE.—Cast iron, $20 to $30 per ton. Wrought iron, discounts as follows, at Pittsburg: 57½ and 47½5 on black and galvanized butt-welded; 67½ and 55% on black and galvanized lap-welded. Casing, 55%.

FOUNDRY PIG IRON.—New York: $14 to $17.50. Pittsburg: $14 to $15.75. Chicago: $14 to $16.

LEAD.—New York: 4.15 to 4.25 cts. Chicago: 3.95 cts. St. Louis: 3.95 to 4 cts.

STRUCTURAL MATERIAL.—New York: beams, 2.3 to 2.8 cts.; channels, 2.3 to 2.5 cts.; angles, 1.9 to 2.1 cts.; tees, 2.4 to 2.75 cts.; sheared iron plates, 1.85 to 2.25 cts.; steel plates, 1.85 to 2.1 cts. for tank, 2.15 to 2.3 cts. for shell, 2.4 to 2.65 cts. for flange, 3 to 3.25 cts. for firebox. Pittsburg: beams, 2.4 to 2.5 cts.; channels, 2.4 to 2.5 cts.; angles, 1.9 to 1.95 cts.; tees, 2.25 to 2.35 cts.; universal iron mill plates, 1.95 to 2 cts.; sheared steel bridge plates, 1.9 to 2 cts.; refined bars, 1.75 to 1.8 cts.; steel plates, 1.9 to 2 cts. for tank, 2.15 to 2.2 cts. for shell, 2.35 cts. for flange, 3.75 to 4.25 cts. for firebox. Chicago: beams, 2.25 to 2.4 cts. for standard, 2.57 cts. for small, and 2.6 to 2.75 cts. for 20-in.; channels, 2.57 to 2.75 cts.; angles, 1.95 to 2.1 cts.; tees, 2.25 to 2.5 cts.; universal plates, 2.12½ cts.; sheared steel plates, 2.2 to 2.25 cts.; steel plates, 2 to 2.1 cts. for tank, 2.75 to 2.9 cts. for shell, 3 to 3.25 cts. for flange.